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ABSTRACT

Two case studies, one conducted in the Luristan region of Iran in 1974, the other in the Caspian region in 1978, outline a methodology for assessing the problems and potentials of indigenous building methods. They illustrate how the methods can be used and developed to meet present shelter needs and how the problems that exist can be overcome without resorting to new, imported, and expensive solutions, often beyond the financial range of the individuals in developing countries and frequently socially, culturally, and environmentally inappropriate. While the appropriate technology described relates to housing, a similar approach may be useful for school construction. The final section of the document describes a 3-month training workshop for local builders and artisans in 1977 in the Selseleh region, after which the participants became trainers in their home villages and assisted local people in meeting their basic building needs. (NEC)

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IRAN: a case study on

RESEARCH AND DEVELOPMENT OF THE INDIGENOUS BUILDING METHODS, MATERIALS, LOCAL SKILLS AND RESOURCES:

- in Selseleh, Luristan
- in the Caspian region
- training workshop for local builders

by

John Norton

Division of Educational Policy
and Planning

Unesco, Paris

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DEVELOPMENT WORKSHOP

The Development Workshop is a team of architects, planners and researchers from a number of countries who work collectively on the development of indigenous building and planning methods in the Third World. Projects have been undertaken in African, Middle Eastern and Asian countries. Members of the Workshop believe that appropriate solutions to human settlement problems can be developed from indigenous methods which have evolved from and remain in the hands of Third World communities. The Workshop works in the field of rural and urban human settlements. The development of small scale construction industries, technical training and local participation are integral to the Workshop's approach.

John Norton is a founder member of Development Workshop.

SUMMARY

This case study comprises three research programmes. In the cases of Luristan and the Caspian regions, they were directly linked with follow-up practical work.

The participants in the training workshop became trainers of the villagers and assisted them in meeting their basic health, education, agriculture and building needs.

The case study outlines a methodology for assessing the problems and potentials of indigenous building methods. It shows how these can be used and developed to meet present shelter needs and how the problems that exist can be overcome without resorting to new, imported and expensive solutions, often beyond the financial range of the individuals in developing countries and frequently socially, culturally and environmentally inappropriate.

It should be noted that indigenous solutions are well suited to local conditions and that much can be learnt from the way in which they work.

The interesting experiences in appropriate technology described in this document have been in housing; it is being published so that readers may also find this approach useful in school construction.

R·E S U M E

Cette étude de cas comprend trois programmes de recherche. Dans le cas des régions du Louristan et de la Caspienne, ils ont été directement liés à un travail pratique.

Les participants à l'atelier de formation sont devenus les formateurs des villageois et les ont aidés à satisfaire leurs besoins essentiels en matière de santé, d'éducation, d'agriculture et de construction.

L'étude de cas propose une méthodologie permettant de mettre en lumière les problèmes et les possibilités offertes par l'utilisation de méthodes de construction locales. Elle définit de quelle manière les méthodes de construction locales peuvent être utilisées pour faire face aux besoins actuels et comment les problèmes existants peuvent être résolus sans avoir à recourir à des solutions nouvelles impliquant des importations ou des coûts élevés qui vont souvent au delà des possibilités financières des individus dans les pays en développement et sont en général inappropriées d'un point de vue social et culturel et par rapport au respect de l'environnement.

Il convient de noter que les solutions indigènes sont bien adaptées aux conditions locales et qu'en cherchant à comprendre leur essence on peut enrichir la connaissance.

Des expériences intéressantes en matière de technologies appropriées, décrites dans ce document, ont été pratiquées dans le domaine du logement. Ce document est publié dans le but de permettre au lecteur d'appliquer une telle approche aux constructions scolaires.

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RESEARCH & DEVELOPMENT OF THE INDIGENOUS BUILDING METHODS, MATERIALS, LOCAL SKILLS AND RESOURCES.

LURISTAN

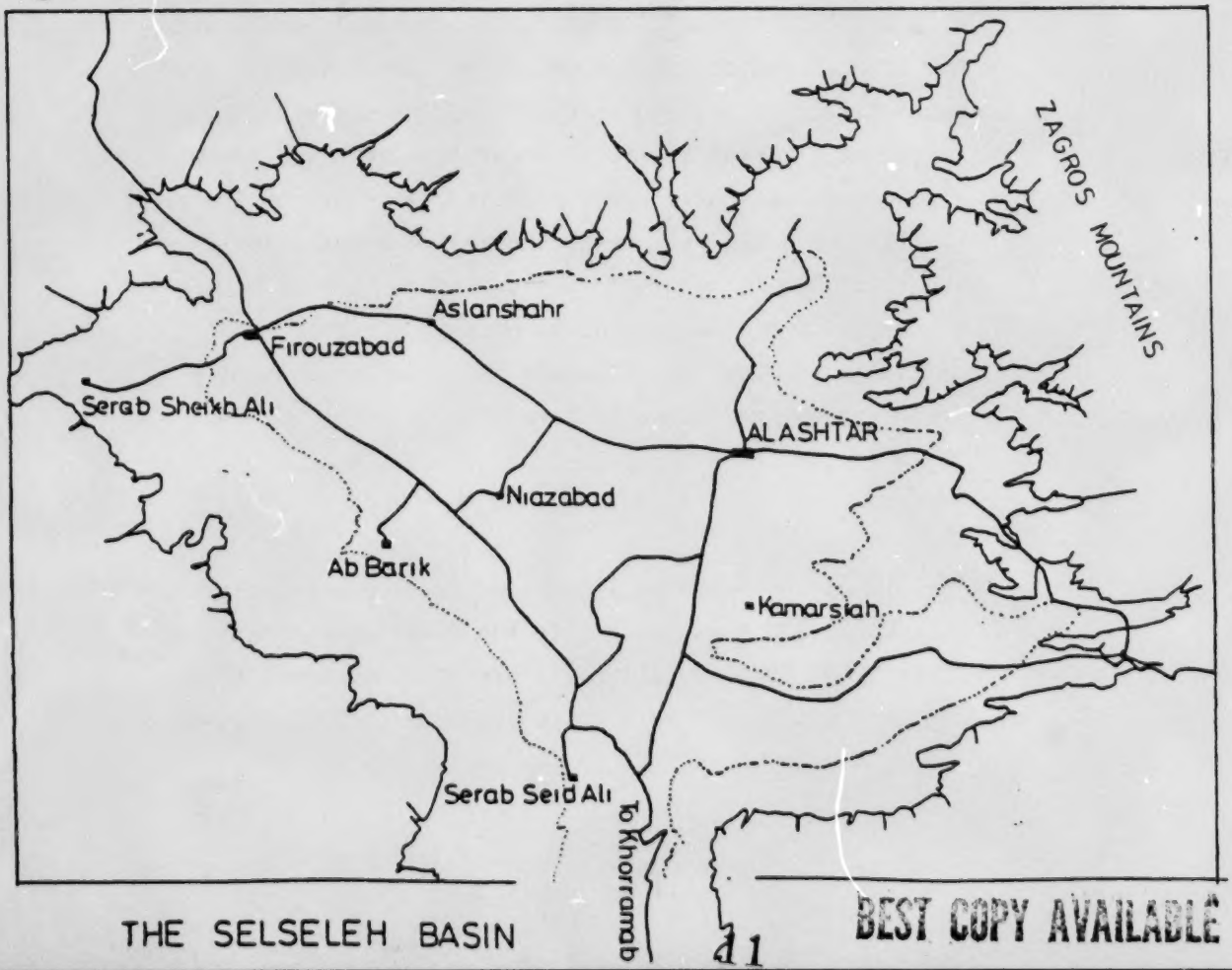
A INTRODUCTION

In 1974 the Selseleh Integrated Rural Development Project was set up in Western Iran. Selseleh is a high plain, ranged by the Zagros Mountains. The project area was approximately 400 km^2 and contained a population of 40,000 living in about 250 villages and homesteads. These settlements are scattered over the plain, which was the main agricultural land, and the foothills, used for dry farming and animal husbandry. The settlements in the plain were wealthier than those on the foothill slopes, where it was harder to make a living. (Fig. B 1)

Although this part of Luristan Province, within which Selseleh lies, has a history of settlement, in the more recent past up to 1930, there were few sedentary villages with the exception of Alashtar, the regional centre and the site of ancient settlement. The Lurs lived off agro pastoral activities and sold their animals and products to the main market centres. Their existence was primarily nomadic and their experience in providing for their shelter needs was best developed in the nomadic tents and responded to a nomadic way of life. As from 1930, the majority of the population became, at least in part, settled. Villages and extended family units developed in the areas traditionally belonging to each specific tribe.

The aim of the Selseleh Integrated Development Project (S.I.D.P.), in relationship to the rural development policies being pursued nationally and in other parts of the country, was to put into operation an alternative rural

Fig B1 LOCATION OF SELSELEH & DETAIL



THE SELSELEH BASIN

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development policy based upon the concept of 'endogenous' or internalised development, which called for the improvement of living conditions within the region through active participation of the community and by the use of local resources wherever possible. This approach implied a process of ongoing research and discussion with the indigenous population.

Development Workshop employed as the group primarily responsible for the development of the built environment programme within the S.I.D.P. framework. From the beginning of the programme the demand for immediate building activity was great. Very few public facilities existed in the region; of those that did, most had fallen into disrepair. However, before any building work could be undertaken, a much greater understanding of the built environment of the region needed to be acquired, as well as finding out what skills were available in the region. Even though recent experience of building had been limited, the forms and basic uses of materials were responsive to the local conditions.

Early research showed that the region's built environment was poorer than it had been even 30 or 40 years ago. There were still people who claimed to remember skills and techniques which had been in more common use but had died out as demand and the finance had disappeared.

The research required to understand the requirements, potentials and problems of the built environment in the region divided up as follows:

1. Analysis of climatic information and other existing documents concerning the area.
2. Research and analysis of house form.

3. Research and analysis of building materials, skills and resources in the area.
4. Investigation into the possibilities of building material production.
5. Investigation of specific problems related to public building with particular reference to public baths.

1 ANALYSIS OF CLIMATIC INFORMATION AND OTHER DOCUMENTS CONCERNING THE AREA

1.1 Climate

No reliable climatic data was available for the Selseleh Region. Climatic data had to be extrapolated from meteorological stations in Khorramabad, Arak, Desful and Kermanshahr, with consideration taken for different altitudes and location. This information was updated and checked against local recordings made during the following 4 years. The climatic data chart gives an indication of the basic pattern. There are cold wet winters and warm, but seldom uncomfortable, dry summers. The rainfall during the winter and spring is at times extremely heavy. Much of the plain is waterlogged during the spring months and movement around the region is restricted. In winter there are short periods of heavy snow. Local inhabitants agree that the prevailing wind is from the south-west, with small local variations due to topography. The mountains surrounding the Selseleh Basin to a certain extent protect it from extremely bad weather in winter. (Fig. B 2)

1.2 Documentation

Very little recent contemporary information existed regarding the built environment. Few writers had travelled in the area and studied the people. Most documentation focusses upon the archeological interest in the area. Luri Bronzes have been found within the Selseleh

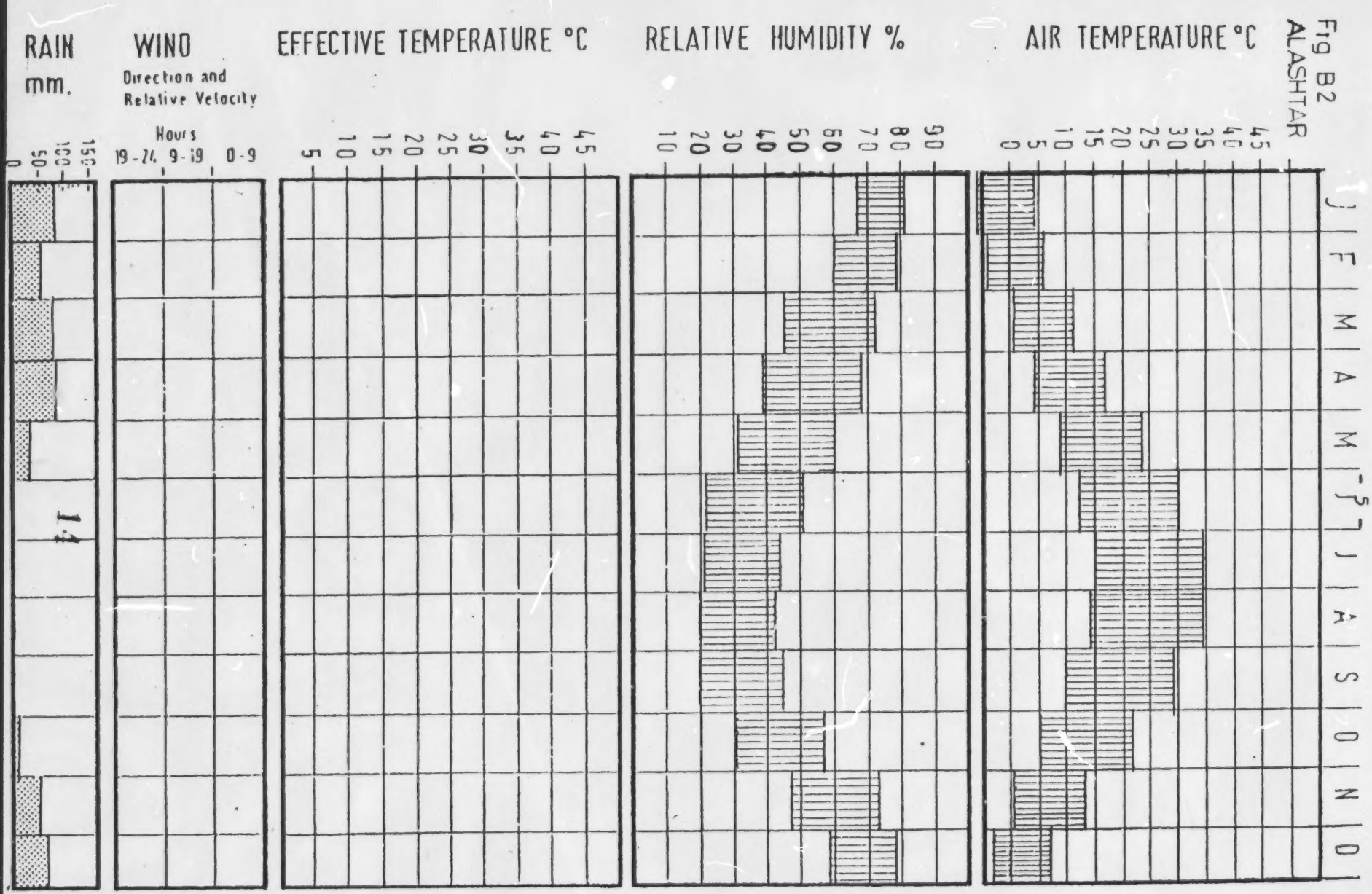

Fig B2
ALASHTAR

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Plain and there are a number of unexcavated sites in the neighbourhood of Alashtar.

2. RESEARCH AND ANALYSIS OF HOUSE FORM

2.1 House form

Houses in the Selseleh region are single storey, but usually have semi underground basements, below the living rooms, where animals are kept. Walls are made of stone or mud and support flat roofs held up by timber beams. The size and length of the available timber is a major factor dictating the dimensions of rooms. Few rooms are wider than 3 to 3.5 metres and are usually 5 - 6 metres from front to back.

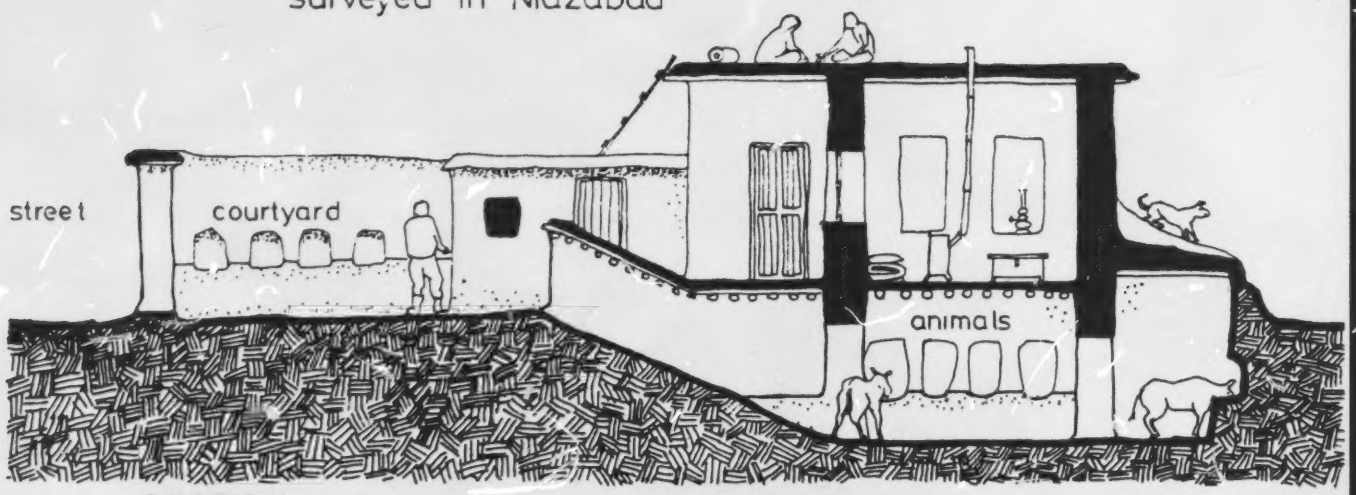
Roofs are covered with mud and, as with walls, require constant maintenance during the rainy season.

Except where the local physical features make it unsuitable, all houses face towards the south, and windows are positioned in the south facing walls.

There are two basic plan forms, one an extension of the other. The basic house consists of two rooms, one at right angles to the other. In front of the room with its longest side facing south is a covered open verandah (aivan) which provides shade in the summer, access from one room to the other where interconnection is not provided, and, by its overhanging roof, stops summer sunshine from penetrating into the room behind. This is basically an 'L' shape house with verandah. (Fig. B 3) Its extension adds another room to the other side of the verandah, symmetrically matching the room on the original side.

Very few washing facilities are provided, except where a well or pool is situated in the courtyard which in nearly all houses encloses the space in front of the house. In summer food is prepared outside or under the shade of the verandah. In winter on days when conditions make it

Fig B3 TYPICAL LURI HOUSE
surveyed in Niazabad



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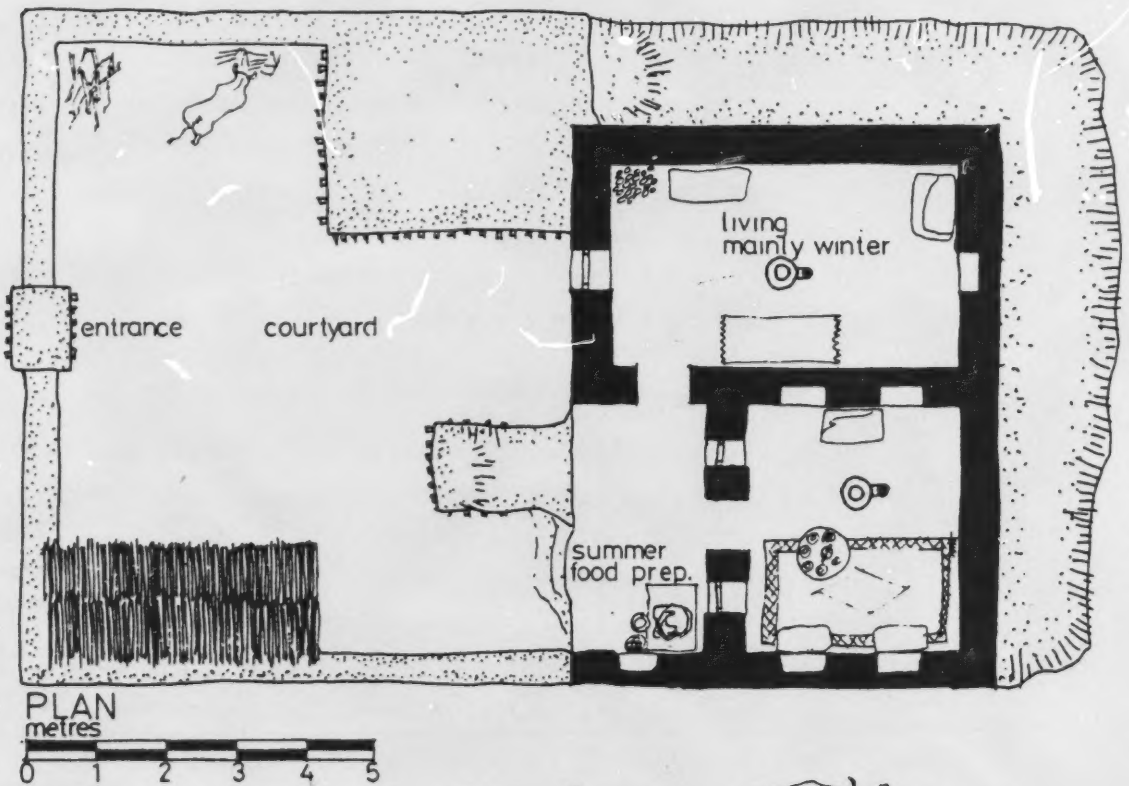

PLAN
metres
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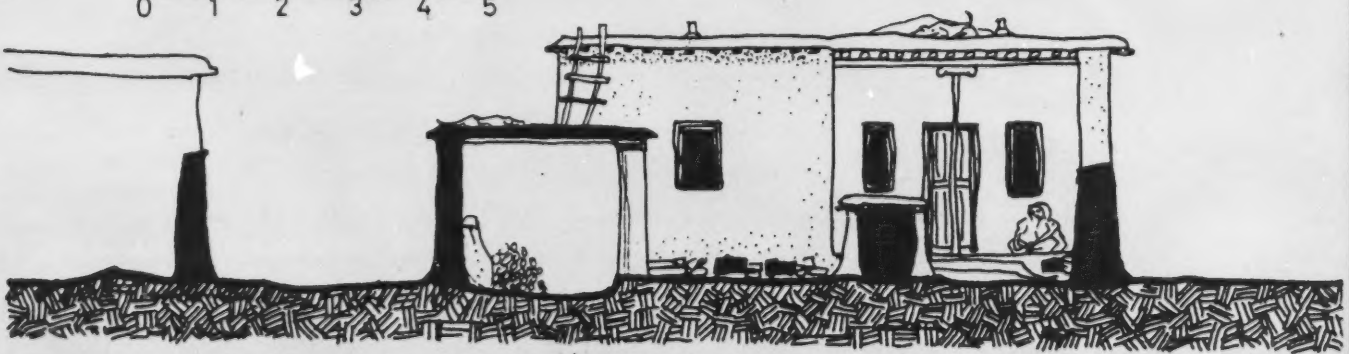

ELEVATION

necessary, food is prepared in one of the rooms. There is very little fixed furniture. Bedding and belongings are stored in alcoves in the walls. Sitting and eating is done on the floor. Winter heating is by woodfired or more recently oil/parafin fired stoves. Chimneys are metal and are erected when needed but are not permanent. Much of the summer living takes place outside, and responsive to the nomadic background, many people move into tents during the summer, sometimes at some distance from the house.

Rooms are used primarily for privacy (not a major factor amongst Lurs), security and warmth in winter.

Animals live in the basement and the heat generated by their bodies is appreciated as a source of warmth by the humans upstairs.

All houses have some form of access to the roof, since it is used for drying crops in the summer, whilst during the winter the compacted mud needs to be rolled after every rain storm, and snow has to be cleared away.

2.2 Climatic performance

The massive construction of walls helps to store heat during the winter and to keep interiors cool during the summer. The windows are positioned to let sunshine into rooms during the winter when the sun is low in the sky and its heat is needed. Because of the overhanging roof and the depth of the window opening, little sun penetrates the house during the summer. Openings on the East or West elevation of the building would not provide this control. Some new houses in Alashtar have paid less attention to the position of windows, but in general it is a well understood principle in the region and Iran in general.

Roofs, made of 15 - 20 cms of mud on top of the supporting timber framework, have a good insulation value.

One noticeable change in housing in recent years has been the size of windows. Fuel oils have become more readily available and winter heating is less of a problem than in the past. Windows have in consequence become larger, which, whilst allowing heat to escape at night, does let in more heat during the sunny winter days.

2.3 Improvements in design and layout

It was felt that two areas required particular attention in terms of the design of houses. a) Provision of lavatory and washing facilities, b) Cooking and food storage facilities.

During the period of the survey (covering the years 1975-1978) very few houses visited had any form of lavatory, and in the absence of public baths in villages, people used the neighbouring open spaces/fields. This led to unhealthy conditions, and attempts were made to provide running water in villages, and to introduce, by example, suitably designed excreta disposal systems.

Whilst nobody objected to certain types of food preparation outside, very often food was prepared and stored in unhygenic conditions, and, again by examples, suggestions were made to improve food preparation and storage areas.

3 RESEARCH AND ANALYSIS OF BUILDING MATERIALS AND RESOURCES IN THE AREA

3.1 Walls

In the Selseleh region, walling materials in the villages are stone, mainly on the foothills, and mud, in the agricultural plain. Both of these, but particularly mud, needed improvement to protect them against rainfall, snow and impact damage. The method of laying stone walls was also potentially unstable, especially mud mortars were used for building with stone. The area is an earthquake high risk zone, and the introduction of measures

to resist the effect of earthquakes was essential. Especially in the regional market town, fired brick was in fairly widespread use, but most commonly as a facing material backed by mudbrick. The cost of fired bricks, brought in from outside the region, restricted its more widespread use.

Because of its cheapness and availability, as well as its good thermal performance, it was felt worthwhile to encourage the use of mud, especially mud brick, whilst attempting to overcome the problems that its use involved. The following suggestions were made, and through example and builders training programmes, disseminated to the villagers:

a. Mud brick should be stabilized to make it stronger and more water resistant, and stabilized wall renders should be used. Various different methods were researched and used on S.I.D.P. buildings with local builders.

b. Where stone or fired brick are used, they should use proper mortars, of which the most readily available was a lime/sand mortar. Very little additional expense was involved in its use. Many people had already turned to using cement for mortars at much greater expense.

c. All walls using mud bricks, fired bricks or stone should be laid with proper bonding between different parts of the wall.

d. Where possible, reinforcement, (timber framing within the structure) should be used to resist movement in a building in the event of an earthquake.

3.2 Roofs

The traditional roofing system on houses used large timber beams (15 - 20 cms diameter) at very close intervals,

with boards or cardboard between to support a layer of mud, 13 - 20 cms thick. The mud provided the protection against rain and insulation. These roofs needed constant attention during the winter, and in addition were expensive in their use of timber and extremely heavy.

Based upon experiments conducted, the following suggestions were made:

a. The use of a stabilized mud finish would reduce the amount of maintenance required. The most practical stabilizing material locally was bitumen. This was already being used as a waterproof barrier on public buildings, but in quantities which would be expensive for most private building.

b. The roof structure used large numbers of expensive timber beams. Alternative methods of laying the timber were suggested and demonstrated, which would reduce a) the amount of timber being used and consequently the cost, and b) the number of trees being felled. Timber for roofing was grown specially for the purpose in plantations in the region.

3.3 Development and dissemination of new or improved solutions.
The builders training programmes which were organised as part of the S.I.D.P. activities were used as the main medium for developing solutions to the local problems in building, and for spreading the information.

4 RESEARCH INTO THE NEEDS AND POTENTIALS OF BUILDING MATERIALS PRODUCTION UNITS.

Analysis of the regions potentials showed that there was the capability for locally producing lime, chalk and fired brick. All three materials were being brought in from outside the region. Before any implementation of

this part of the programme took place, we visited production centres in neighbouring regions, especially those where the people were acquainted with our region. The purpose of these visits was to find out if there were any local problems in the processing of the materials mentioned. At the same time, through discussion with local builders and by visiting the areas near older settlements in the region, particularly near Alashtar, traces of old kilns were found, including bricks of considerable age produced locally. (The establishment of small scale production centres will be discussed in Case Study 3.)

In addition to the more obvious resources of the region, it became apparent that considerable sums of money were leaving the region in order to purchase doors, windows, hot water boilers, simple furniture etc. A further aspect of the research was to investigate what skills and equipment was available locally for the production of these items, and through discussion, to find out what sort of assistance was required to stimulate any local capability that existed.

5 INVESTIGATION OF SPECIFIC PROBLEMS RELATED TO PUBLIC BUILDING WITH PARTICULAR REFERENCE TO PUBLIC BATHS.
Whilst the shelter needs of the region were being met with local resources and skills, the public building of the area was mainly built by contractors coming from outside the region, using non-local materials. This was proving both expensive and did not allow the local population to participate in the public building process, nor learn how to.

A particular aspect involved in the building of public baths illustrates some of the difficulties faced.

Government sponsored public baths were built using rolled steel joists to support the roof. Whilst this was the standard technique for modern roofing in urban building in Iran, in the hot humid atmosphere of the baths these R.S.J's rust and the building deteriorates. On the other hand, the local system of roofing used timber and mud, which, whilst being much cheaper, also deteriorates quickly in the bath's atmosphere.

It was necessary to find a roofing system that was cheap, suitable, within the range of local skills and locally acceptable. Two traditional baths were found in the area, one in Aslanshahr, the other in Alashtar, both of which used vaults and domes to roof the bath, providing a roof which will not be seriously affected by the bath's dampness. (Fig. B.4)

TRADITIONAL BATH IN ALASHTAR, LURISTAN, IRAN

Fig. B.4 SECTION

However, initially there was no evidence in the Selseleh area that anyone knew how to build either vaults or domes.

Through further investigation, villages were found where mud brick vaults were still being built, to cover the basements of houses, and through discussions with local builders in the Selseleh area, it transpired that one or two of them had known how to build both vaults and domes in the past, but that through lack of practice had lost the skill over the years.

Lack of finance in the area had greatly reduced the occasions when a builder had been called upon to demonstrate or maintain his skill. In general a low standard of building skill had been sufficient for most of the work being undertaken.

In order to create a team of local builders capable of building baths (and other public buildings needed in the area) a training programme was required, to re-introduce a skill that had died out.

Two master masons were brought from Central Iran (Yazd), where vault and dome technologies are highly developed and very much in current use. These master masons were hired on the understanding that they were prepared to teach and share their knowledge with the 'trainee' builders in Selseleh. All the S.I.D.P. building work was undertaken on a basis of training through practical experience, with the more skilled passing on their knowledge to people from the villages.

6 CONCLUSION

The understanding of conditions in the Selseleh region, and the difficulties that existed, was not achieved through a comprehensive research programme. Demands to start the work of building public facilities took up much of the time. The basic knowledge of the area and its indigenous built

environment was complemented in the following years by the knowledge that builders and others from the area already had. Many of the ideas that were later put into practice were based upon their suggestions, and equally, systems developed elsewhere were adapted to meet local requirements through the builders' understanding of their own locality and building needs.

The local people began to develop an investigative attitude towards meeting their own shelter needs, and through this an ability to find solutions to new problems when they arise. Underlying this was a renewed belief that it was possible to solve many of the local problems through the use of their own skills and resources.

CASPIAN

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RESEARCH AND DEVELOPMENT OF INDIGENOUS BUILDING METHODS, MATERIALS, LOCAL SKILLS AND RESOURCES

THE CASPIAN

1. Introduction

In 1978 a research programme was instigated as the pilot phase for the development of the built environment in the Caspian Region of Iran *1, covering the provinces of Gilan and Mazandaran *2. (Fig C.1)

2 Aims

The aim of this programme was two fold. Firstly, few people in official decision making positions were acquainted with the real needs, potentials and conditions of the region. For decisions to be made which could accurately reflect the local requirements the information had to be collected and presented in a way that could be used by decision makers. Secondly, the more direct aim was to understand the problems and potentials of the built environment in the area, and through that process, ascertain what assistance could be given to:

1) Improve the quality of the built environment.

2) Stimulate the use of local materials/resources where possible and through this generate more local employment opportunities and less dependance upon imported skills or materials, i.e. from Tehran or abroad.

*1 Documented in: DARAIE. M; CAIN. A; NORTON. J; AFSHAR. F. INDIGENOUS BUILDING OF THE CASPIAN REGION Tehran, Institute for Peasant and Rural Studies. 1979

*2 This programme was sponsored by the Iranian Institute for Peasant and Rural Studies. Tehran, Iran.

Fig C1 LOCATION OF CASPIAN IN IRAN

3 Programme for study

The overall research programme was conducted by an average of 4 people over a period of 6 months, including the time for analysis and production of the results as well as the field work. The field work was done in 3 trips, firstly to Gilan, then to Mazandaran, and a final more selective trip to study certan areas in greater detail in both of the provinces.

Before the field work documented information was collected in Tehran. This included maps, climatic data, and any information already available. There were already some detailed studies of specific villages and neighbourhoods, which, depending on their degree of detail, were later used to cross check the findings of the field work period and were useful in giving an indication of changes that had taken place in the time that had elapsed since the earlier studies were done.

The information on the Caspian Region was gathered on three broad levels: visual observation, physical surveys and case study interviews.

While travelling through the region, visual observations on changes in house types, building materials, settlement pattern and distribution, as well as topography and land use, were recorded in writing and small illustrations, taking the form of Route Notes. This information was also documented photographically. Similar visual observations were recorded on settlements and houses. This material provided a valuable broad reference to the whole region.

Settlements were selected at regular intervals throughout the region and physically surveyed. The settlement

pattern was drawn up and observations were made on the local topography, climate, water resources, social characteristics and building resources, at the same time noting what influence these have had on the form of the settlement. In each settlement several representative houses were selected for detailed survey and many others were sketched and photographed. Plans, sections and elevations were measured and drawn up, and a house observation sheet on space use and building technology was filled in.

In the houses surveyed in interview on various aspects of the settlement and the house was held, usually with the head of the family. These interviews, in addition to providing detailed current information, also provided much of the local historical information and detailes on the development of the house and settlement.

Based on a preliminary study of the region, physical surveys and interviews were conducted on local building and production industries, complementing the information collected on houses and settlements. Whenever possible, local builders were interviewed in addition to the house surveys and interviews. Builders were asked to demonstrate or explain particular local building methods and their opinions on various building materials and techniques were obtained, as well as comparative costs.

Samples of building materials were also collected and analysed.

4 Caspian Region

The field area for this study was defined by the northern slopes of the Alborz mountains (Fig. C.2); a region which exhibits similar ecological characteristics from Astara

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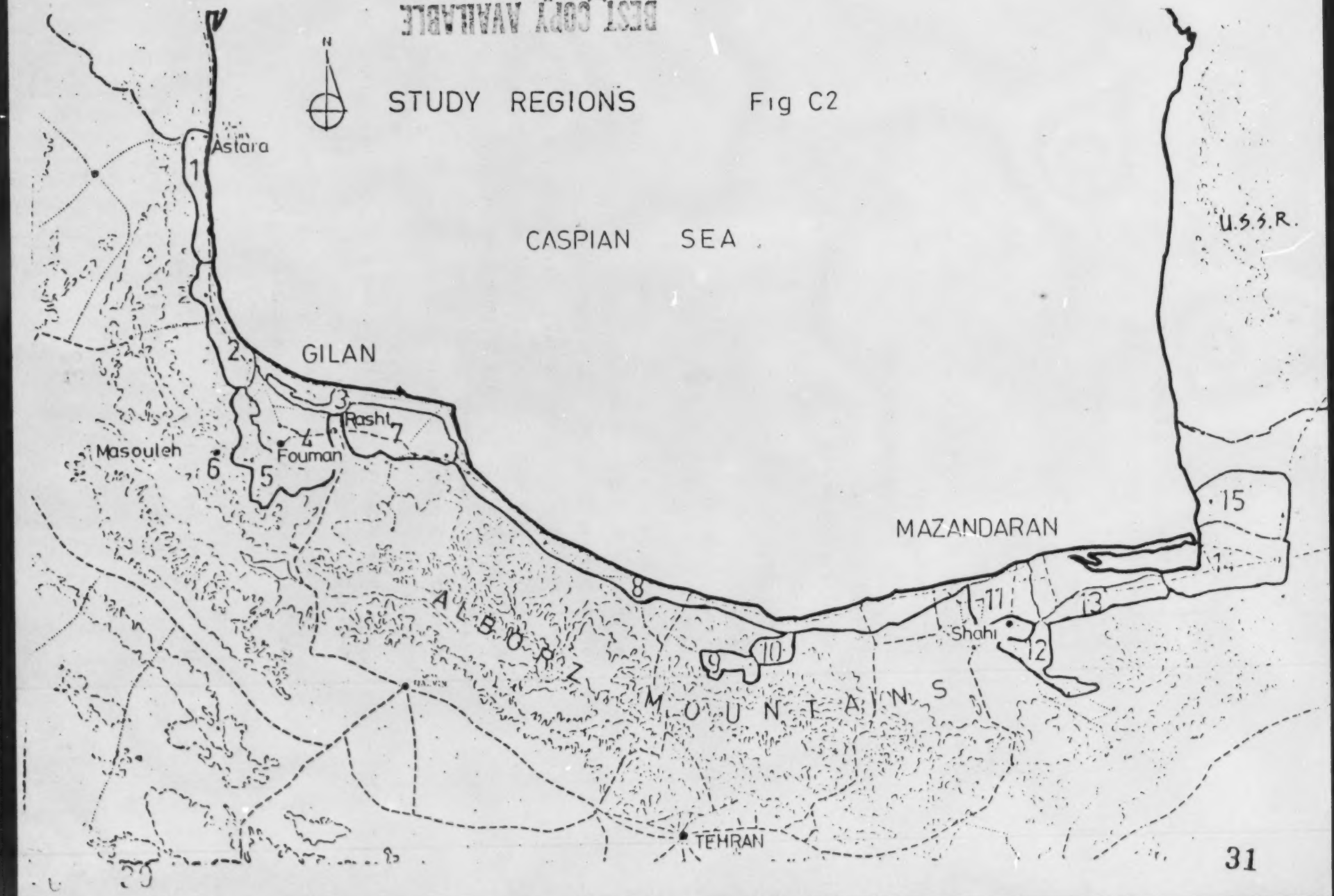


in the northwest to the foothills of Gorgan in the east of the region. The Alborz mountains, forming a barrier to the penetration of rain clouds into the south, contain the abundant rain and humidity on their norther slopes and the coastal plains of the Caspian.

The study area was divided into two broad ecological subregions:
The plains; occupied by a sedentary population who were traditionally engaged in rice cultivation, silk production, and animal husbandry. The plains have a high mean annual rainfill, humidity and air temperature.
The hills; covered by forests and vegetation and provide good grazing grounds for animal husbandry. The population engaged in this activity migrates to the cooler, less humid hills in the summer and returns to the plains in the winter months.

The Caspian's narrow coastal plain has an average width of about fifty kms, and was produced by a general retreat of the sea, which at one time probably extended as far as the foot of the Alborz mountains. Numerous rivers originate in the northern foothills of the Alborz, but they are all short and cover small distances before they reach the sea. There are, however, four rivers of importance that empty their water in the Caspian. They are, the Aras (Arazes), Sefid Rud, Gorgan, and Atrek. These rivers have respectively built the Moghan Plain, the Sefid Rud Delta (Rasht Plain), the Gorgan and Atrek Plains. In addition, a group of rivers - Talvar, Haraz, Babol, and Tejan - have built up the Mazandaran Plain.

The northern foothills and the slight to moderately sloping foothills areas of the Alborz mountains bordering the southern coast of the Caspian Sea are characterised

by a humid and subhumid subtropical climate. These areas include the Caspian provinces of Gilan, Mazandaran, and Gorgan. Climatic conditions in these regions differ from those of other parts of Iran and have certain similarities to the Mediterranean climate; it is humid in the western part and subhimid, semiarid in the eastern part. (Fig. C.3, C.4, C.5)

5 Building techniques, materials and forms.
The particular topographical, environmental and socio-cultural conditions of the Caspian Region have produced a range of building techniques and forms unlike those found in the rest of Iran.

5.1 Roofs
Regional construction variations in the study area are most clearly reflected in the roof types, reflecting changes in materials and micro climate. In general the steepness of pitched roofs decreases from the coast to the mountains. This is most marked in a section taken from the coastal area north of Rasht and passing through Fouman inland to the mountains.

The reason for the change at each stage of this cross section is twofold. Reed thatch is used in the coastal areas because it is the most abundantly available material, growing in the marshes. The pitch of these roofs is very steep where the rainfall is high (1600 mm/year) to ensure water run off; the pitch is shallower where rainfall is less, producing the difference between reed thatch roofs in Gilan (55^{o}) and Mazandaran (35^{o}). In Gilan the coastal houses have large overhanging eaves which reflect the dgree of exposure to, and direction of bad weather. The overhangs often protect frail wall structures behind, such as reed walls. (Fig. C.6)

Fig C3

FOUMAN
Elevation -10m.

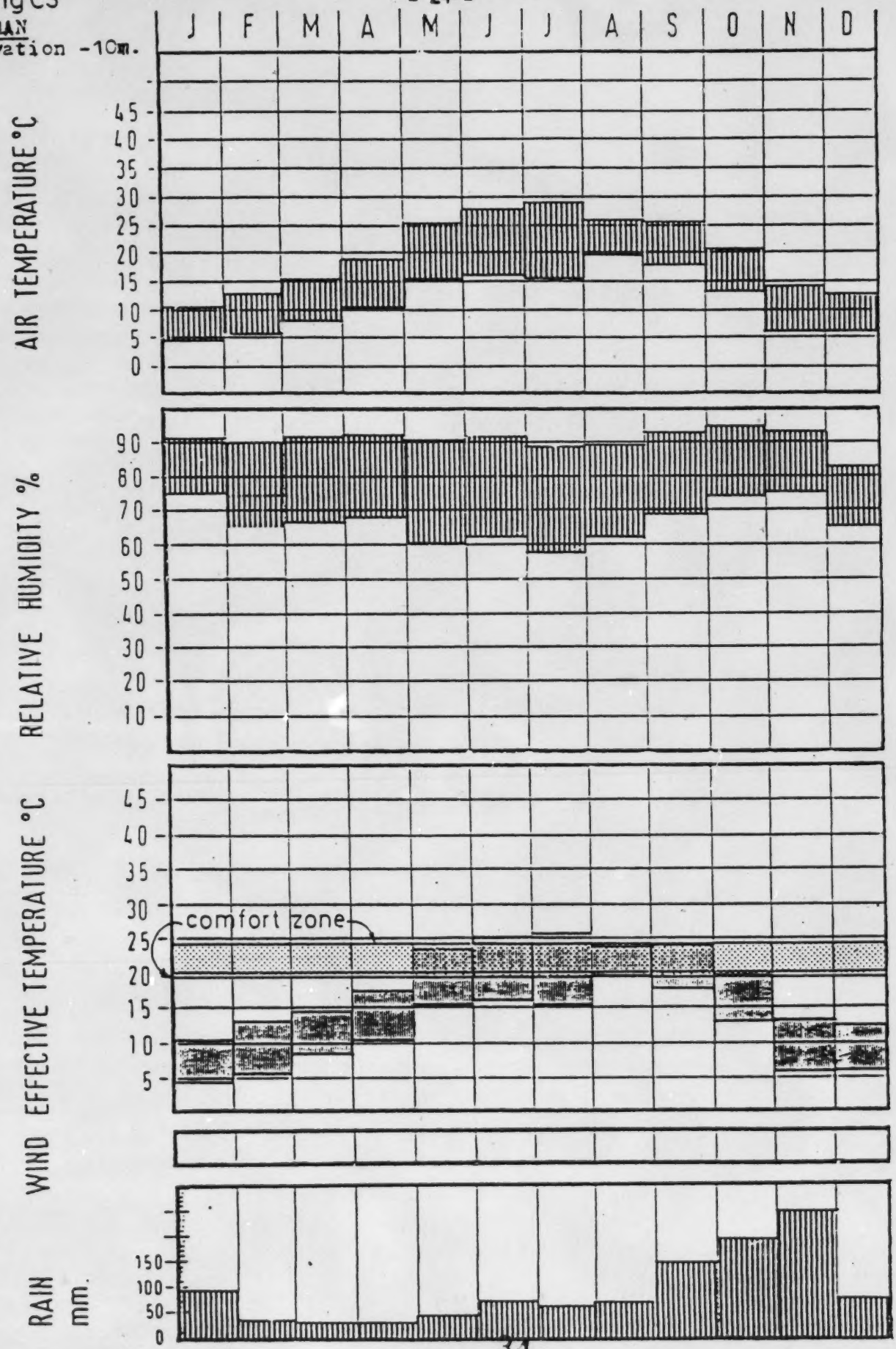
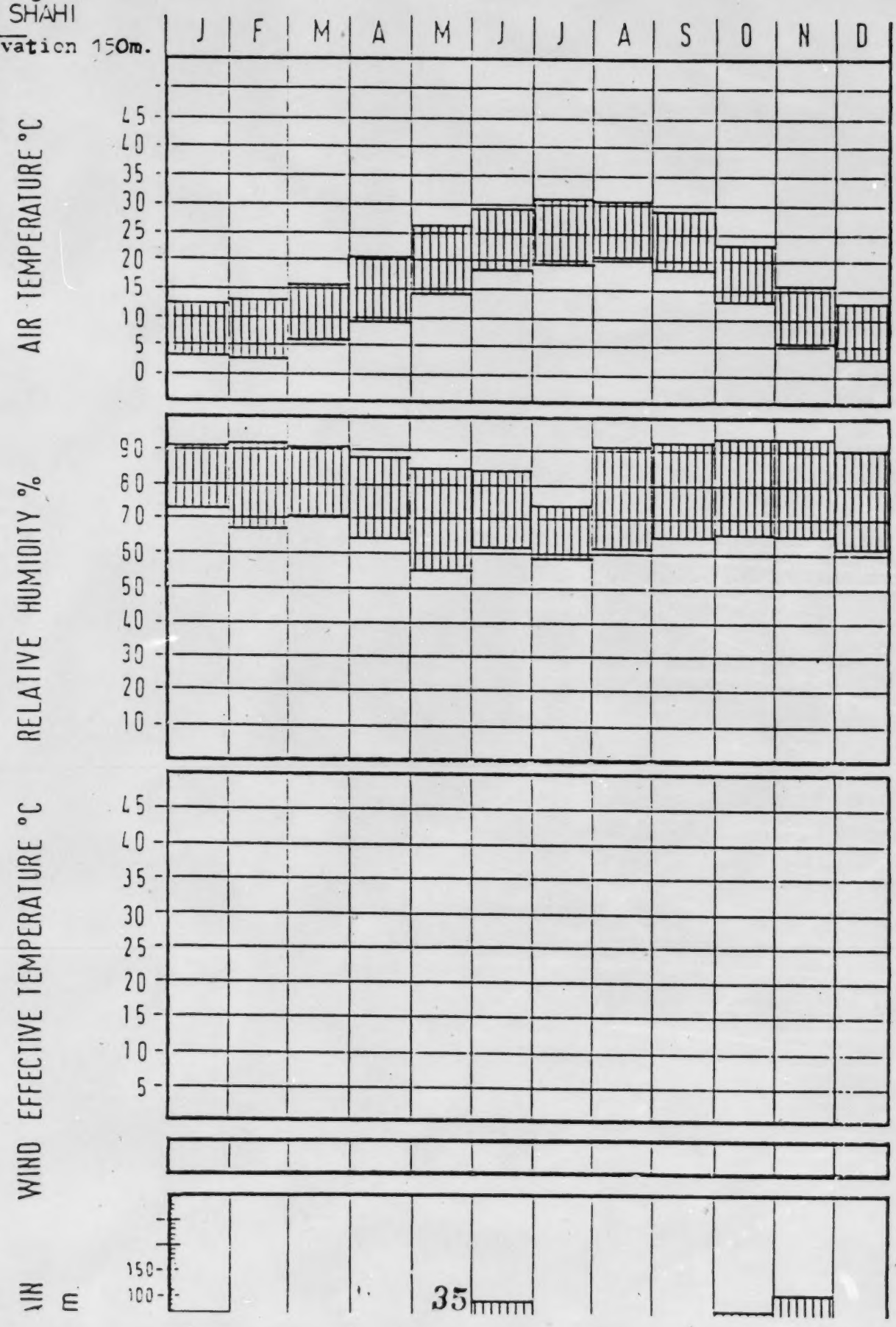
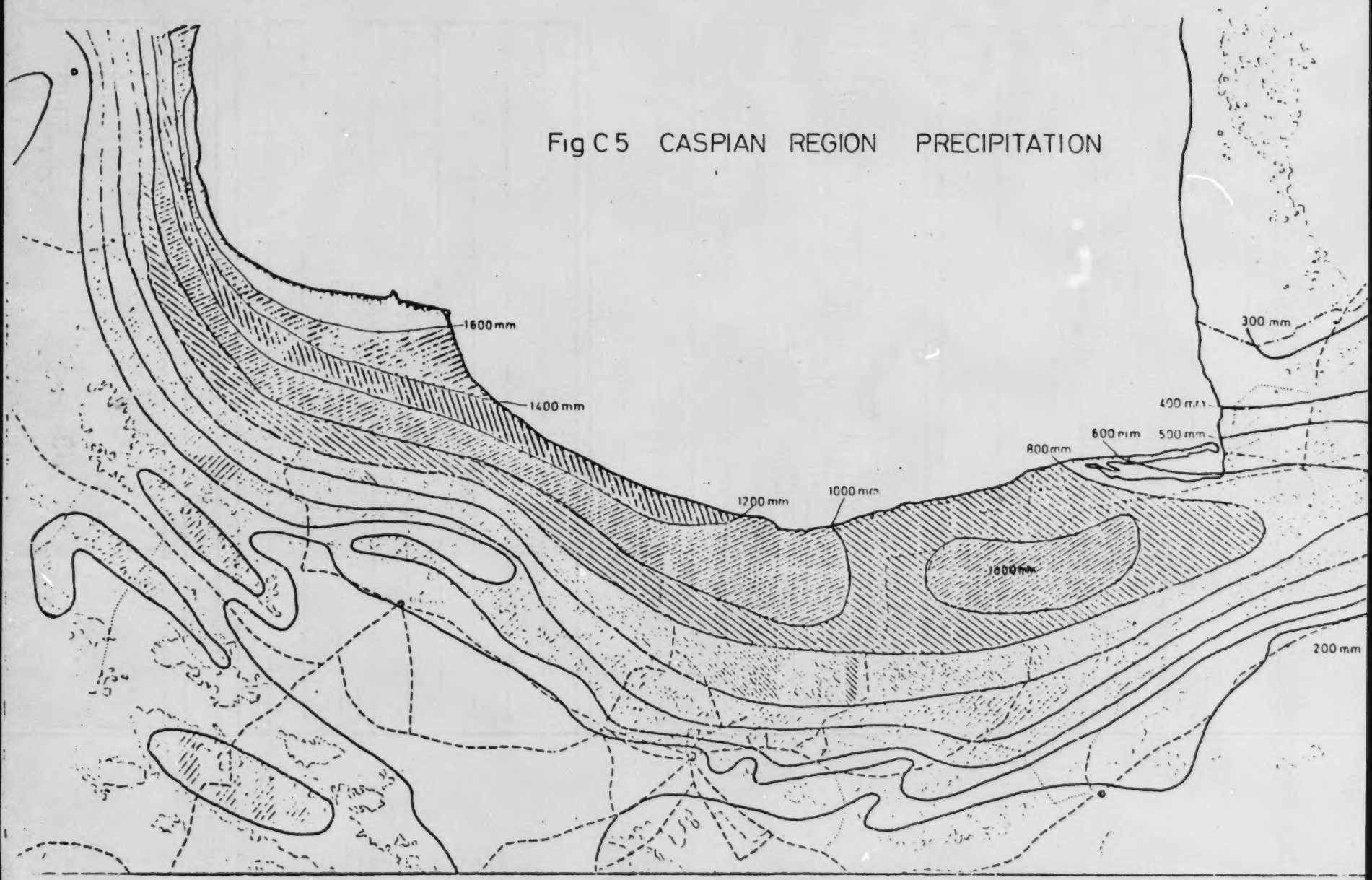

J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
EFFECTIVE TEMPERATURE °C
45 40 35 30 25 20 15 10 5
comfort zone
WIND
RAIN mm.
150 100 50 0

Fig C4
SHAHI
Elevation 150m.


J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
WIND EFFECTIVE TEMPERATURE °C
45 40 35 30 25 20 15 10 5
IN m
150 100

TRAINING AND VISIT

Fig C 5 CASPIAN REGION PRECIPITATION



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Moving inland reed is replaced by rice thatch. Rice is grown over much of the Gilan plains. The pitch is shallower (40^{o}): the rainfall is less (1000 mm/year). (Fig. C.7)

At the junction of plains and foothills, as forests start replacing fields of rice, wood shingles replace thatch. These shingles allow the roof pitch to be much shallower, and as the rainfall decreases into the mountains, the pitch can be further lowered. There is a progression from 35^{o} to 25^{o}. (Fig. C.8) Although there are exceptions, such as Masouleh, the change from shingles to flat timber and mud roofs occurs at the point where there is insufficient rain to support forests, altering the materials which are available for roofing, and where the relative dryness of the climate makes flat roofs practical. Flat roofs are typical of the drier slopes and plateaux of the mountains. (fig. C.9)

Tile roofs which occur in areas where soil is suitable for tile production (Astara, Behshar and the towns of the Rasht/Lahijan area), are in exception to the pattern outlined above, since they are suitable for use in areas of heavy rainfall without requireing a steep pitch.

Similarly, sheet metal roofs do not reflect local changes in climate, the exception of those in the Turkomansahra area where a peculiar 'H' ridge form of sheet metal roof is, according to locals, to assist in the collection of rainwater. (Fig. C.10)

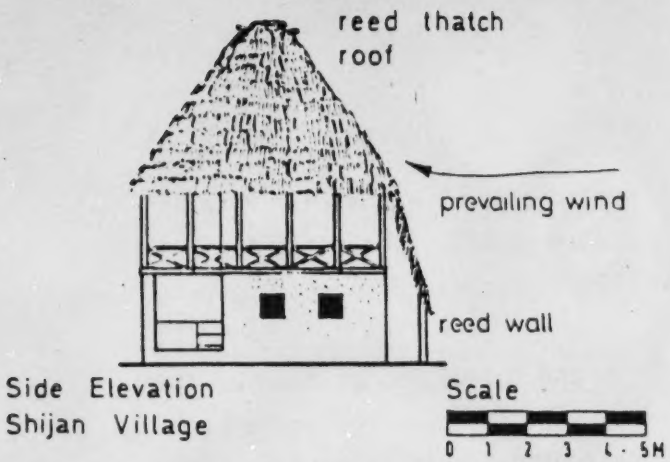

Fig C6 REED THATCH HOUSE

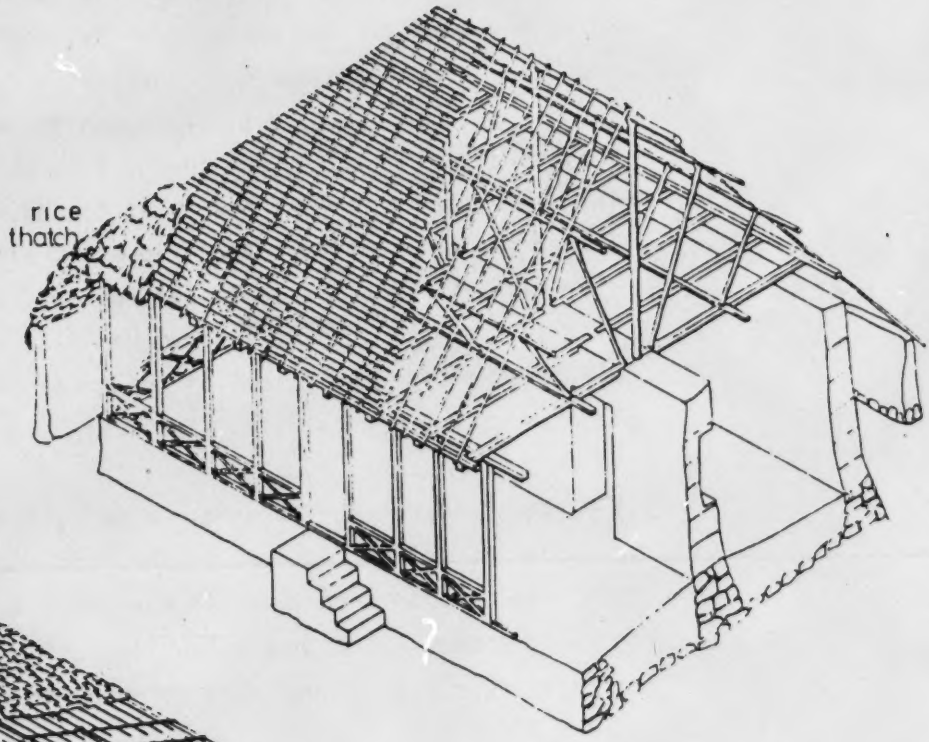

Fig C7
RICE THATCH
HOUSE

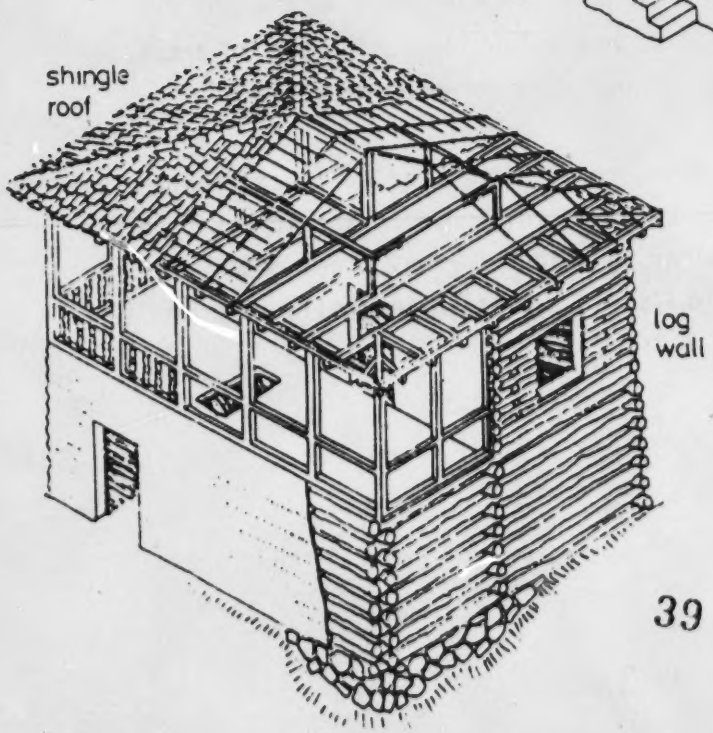

Fig C 8 SHINGLE ROOF
HOUSE

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Fig C9 FLAT ROOF HOUSE

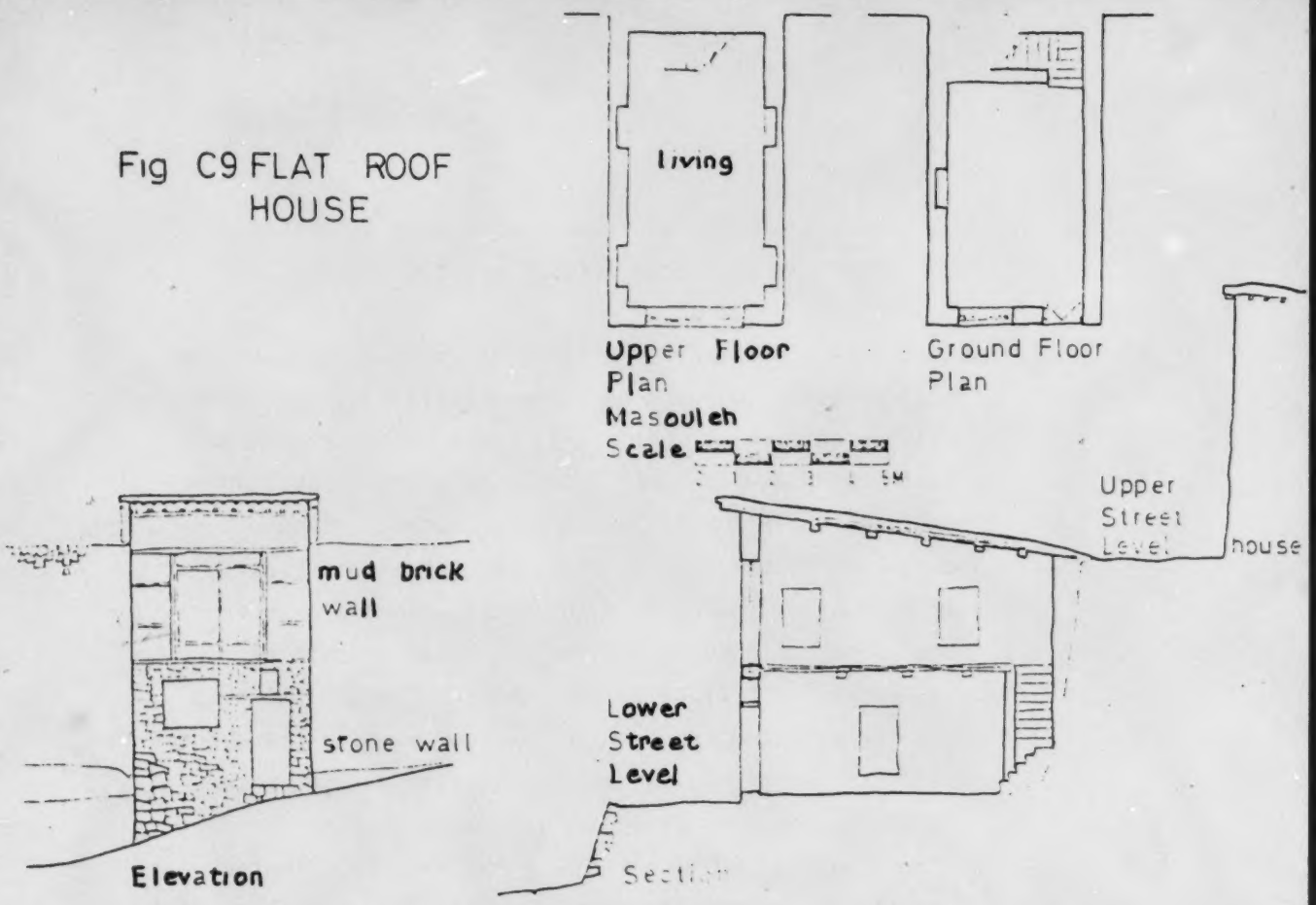
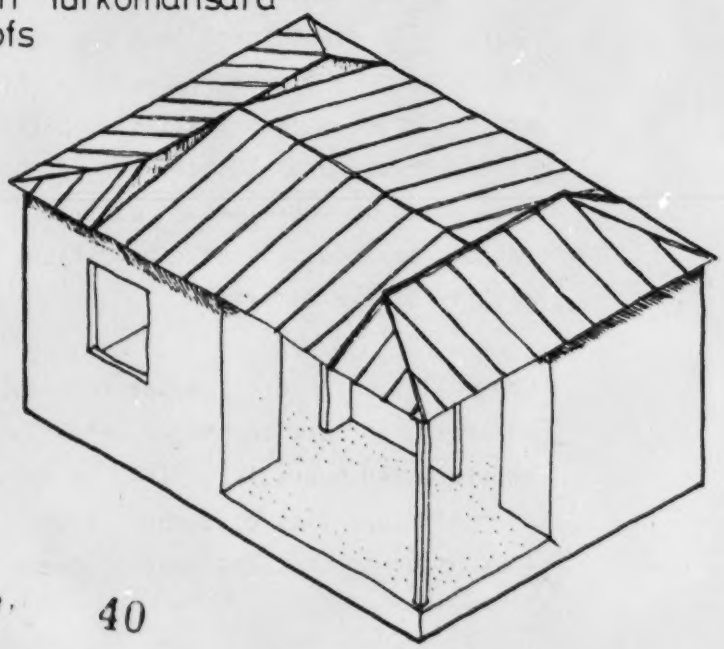


Fig C 10 Houses in Turkomansara have unusual roofs



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5.2 Walls

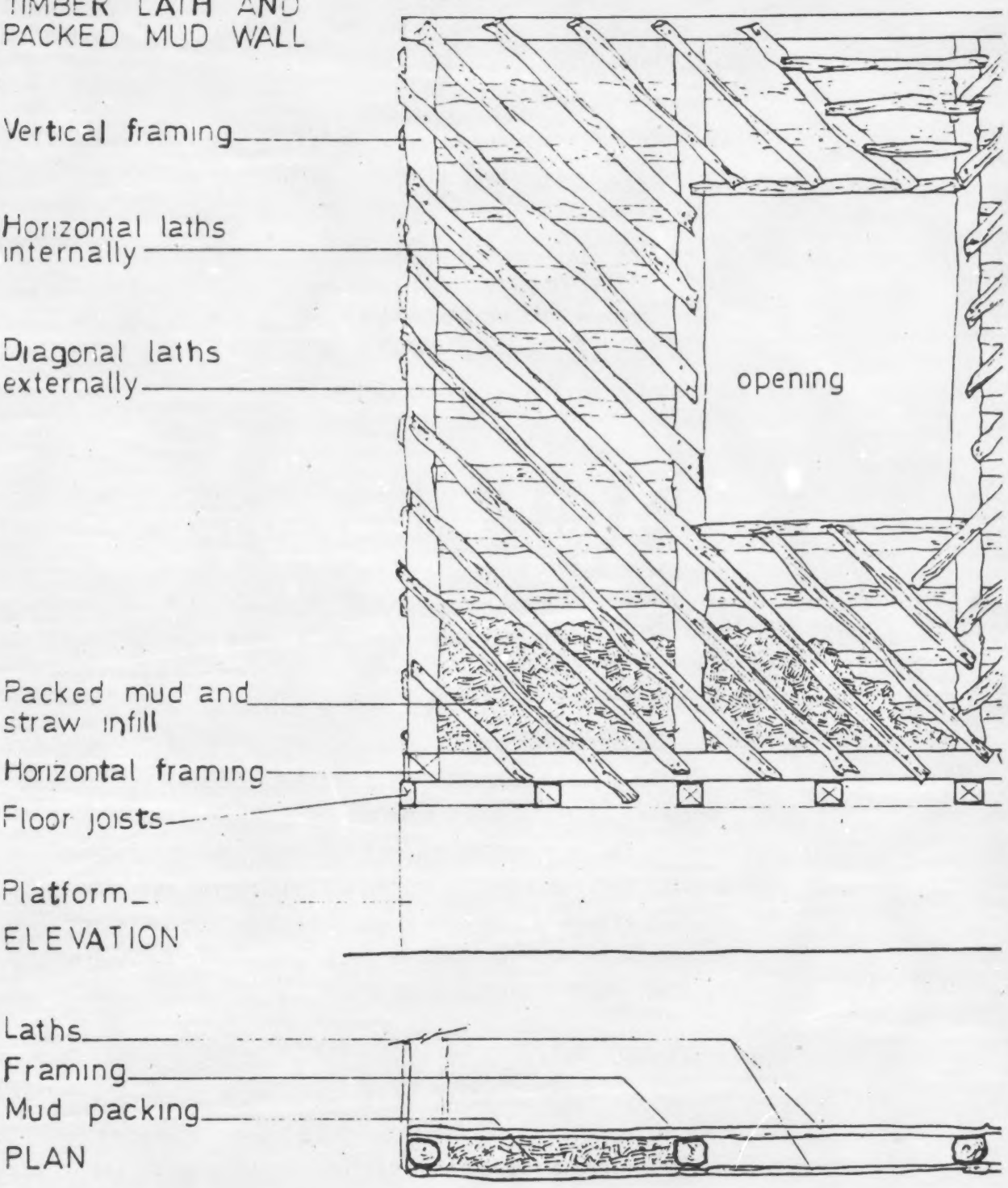
Walls, in the same manner as roofs, vary according to the materials available locally and the climate.

Reed walls supported by a timber framework occur in the coastal areas, where reed is more available than other walling materials. (Fig. C.6) This wall type is well suited to the warm humid conditions of the coast, where thermal insulation is less important than inland, where temperatures are more extreme. A general observation is that walls increase in thickness with distance from the coast. Linked to this is a similar transition from framed wall construction near the sea changing to load bearing wall construction in the mountains. This change reflects changes in the availability of walling materials. Loadbearing walls are naturally thicker than framed walls, and so the change required by climatic conditions is facilitated by the change in the physical properties of the wall.

Moving from the thin reed walls on the coast inland, walls of timber lathing with a packed mud infill occur. These walls are thicker than the reed walls but are still supported by a timber framework. (Fig. C.11) However, where timber is less available, packed earth (chineh) walls are used, as in Sari and Fouman plains. The choice between these two types of walling is influenced by variations in local climatic conditions as well as the suitability of the materials.

Log walls, which are loadbearing, coincide with forested areas, and are the major wall type in the foothills and forested mountains. (Fig. C.8) Because of the good thermal properties of timber, these walls provide greater insulation against extremes of temperature than the thin

Fig C 11
TIMBER LATH AND PACKED MUD WALL



walls found on the coast. The use of log walls is restricted to areas where timber is plentiful, and thick stone or mud loadbearing walls replace logs where the forests decrease inland. At this point thermal insulation is essential to counteract the cold winters and cool summer nights which occur in the mountains, and the thick loadbearing walls are responsive to both the local climatic conditions and the availability of walling materials.

All the wall types mentioned above require rendering and maintenance. A major potential improvement in building quality and maintenance can be through the introduction of improved renders, using stabilisers to make them more water and impact resistant. In areas where the soil is suitable fired bricks are produced and used for walling. (Astara and Behshar) They have the advantage of being less subject to damage by rainfall and consequently require less maintenance. However, the cost restricts the rural use of fired brick even in areas where it is produced. Similarly concrete block has come into use throughout the coast and plains of the Caspian region for those who can afford it. Although it is less environmentally responsive, concrete block is locally believed to be long lasting and maintenance free.

5.3 Platforms

Houses are built on platforms to raise them above damp ground conditions and the risk of flooding. Platforms are therefore a predominant feature in the coastal and plain areas of the Caspian. Two basic forms of platform exist - those which are raised clear of the ground, which occur in areas where rivers are likely to flood (Sefid Rud delta), and those which are solid. (Fig. C.12) Solid platforms are highest near the coast, and in gen-

PLATFORMS

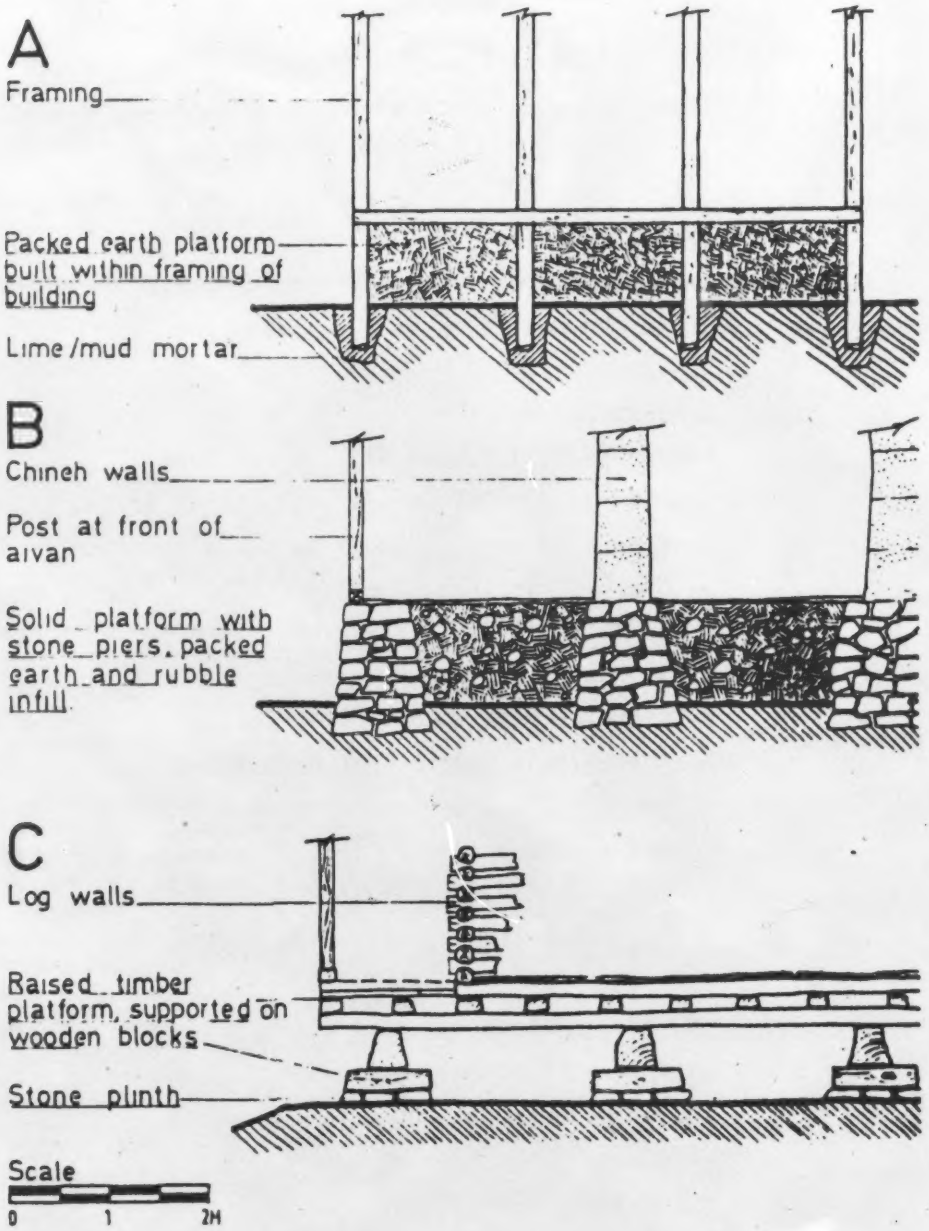


Fig C12

eral get lower towards the foothills, corresponding to the areas with drier and better drained ground.

Platforms are not a predominant feature of mountain dwellings, but visually the levelling of ground below the main structure of the building produces an effect similar to the platforms of the plains.

5.4 Orientation

Orientation of houses also alters from the coast to the mountains. To take maximum advantage of the sun's warmth in winter, houses in an ideal situation face south. with windows primarily on the south wall. However this ideal orientation is not always the most practical. On the coast houses tend to be oriented towards the south-east, turning the back of the house towards the prevailing north-westerly storms. Moving inland onto the plains, a south facing orientation is more practical, since the houses are less exposed to bad weather. The situation is notably different in the foothills and mountains, where topography becomes a dictating factor. Houses primarily face downhill, with their backs turned toward the slope behind. This is not an ideal situation and where the site is sufficiently open towards the south, a south facing orientation is chosen.

6 House form

Any typology of house form can only be a generalisation in a region demonstrating varied natural conditions, economic and social patterns and different ethnic and tribal backgrounds. However, some basic features are common to the whole area, with the exception of Masouleh, which is built on a steep hillside and has houses unique to its own position.

There is a basic type of shelter which is generative of all the other house types. It consists of two fundamental spaces necessary for the house in the Caspian region: an enclosed room and a roofed but unwalled verandah (aivan). The room provides an enclosed space for use during the cooler less humid months and in some areas for sleeping at night; the verandah is a shaded semi enclosed roofed space in which most daytime activities take place, especially during the warm humid summer months. (Fig. C.13)

These two spaces are found in almost all house types in the region but the ratio of room area to verandah and their relationship vary according to the climate and lifestyle requirements within each sub region.

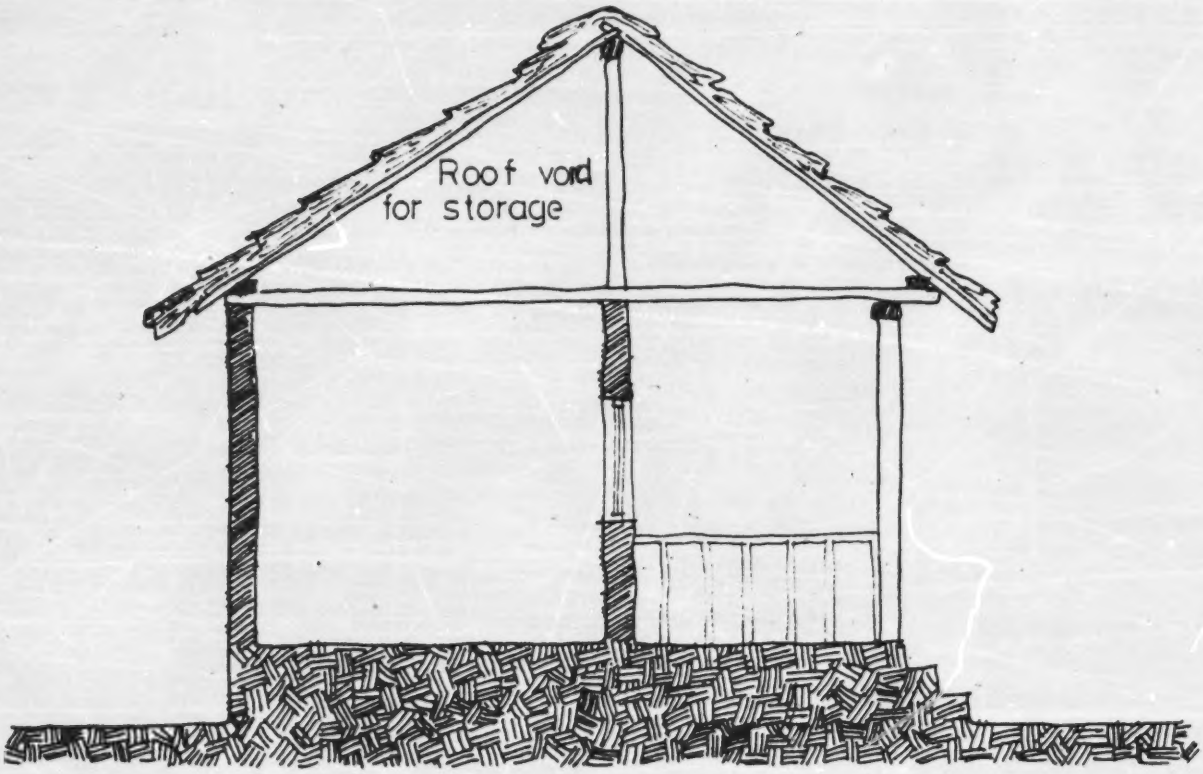
Along the coast, where there are high winds and rainfall, expansion of this basic form is horizontal, with rooms being added side by side and the verandah running across the front. (Fig. C.14) Smaller houses in the Astara region are often 'L' shaped, enclosing the verandah on two sides. (Fig. C.15) Moving inland, the house changes from being single storey and develops upwards. (Fig. C.16) Often the verandah is at the upper floor, with the ground floor being used for storage. (Fig. C.17)

New houses in the coastal areas most commonly adopt the 'L' shape plan, and this is becoming the general regional pattern. Local variation and local response to climate is much less apparent in the more recent buildings.

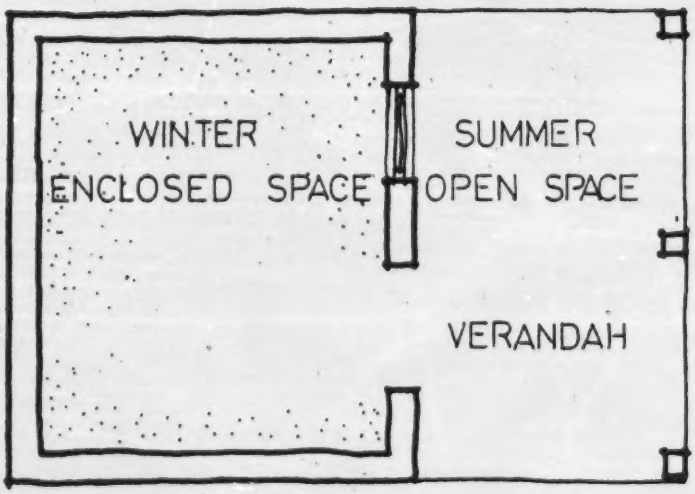
7 ANALYSIS AND CONCLUSION

The development and pattern of rural building in the Caspian Region depended largely upon house occupiers building and maintaining their own houses. This was an understood and accepted pattern. The time involved

Fig C 13 BASIC GENERATIVE HOUSE FORM

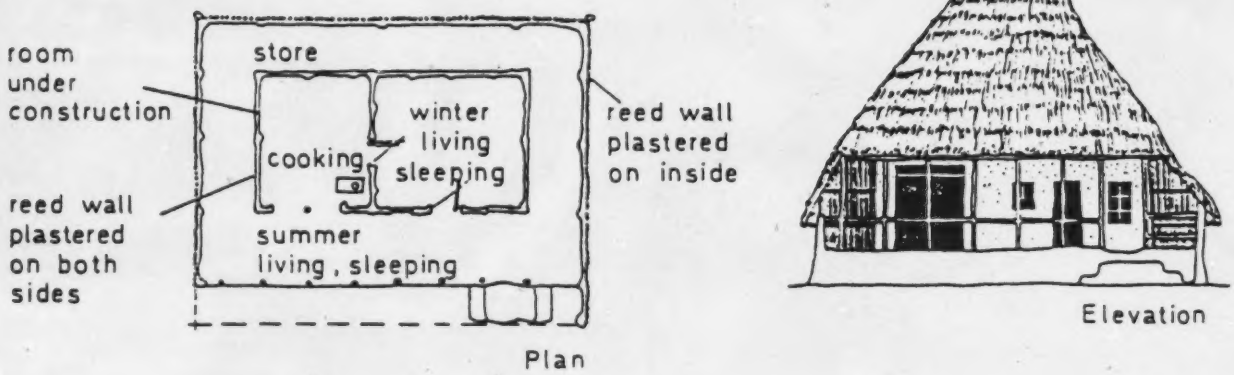


SECTION



PLAN

Fig C14 FRONT VERANDAH HOUSE



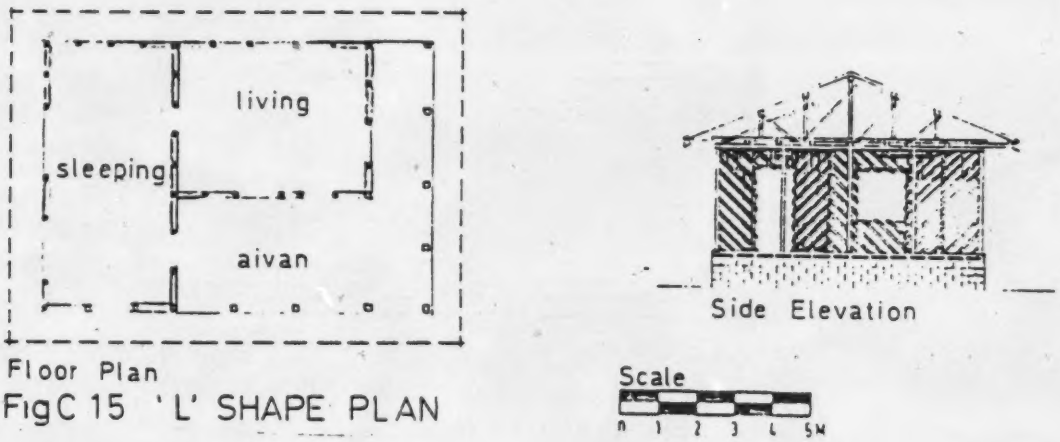


Fig C 15 'L' SHAPE PLAN

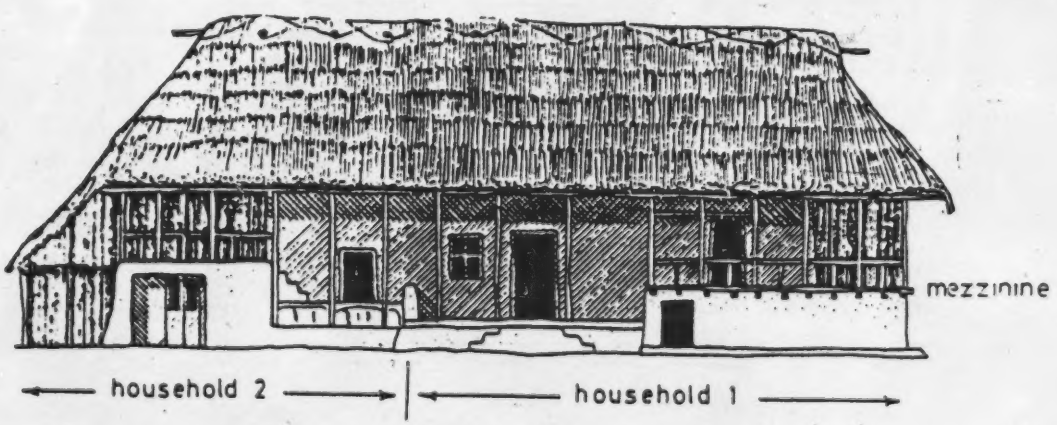
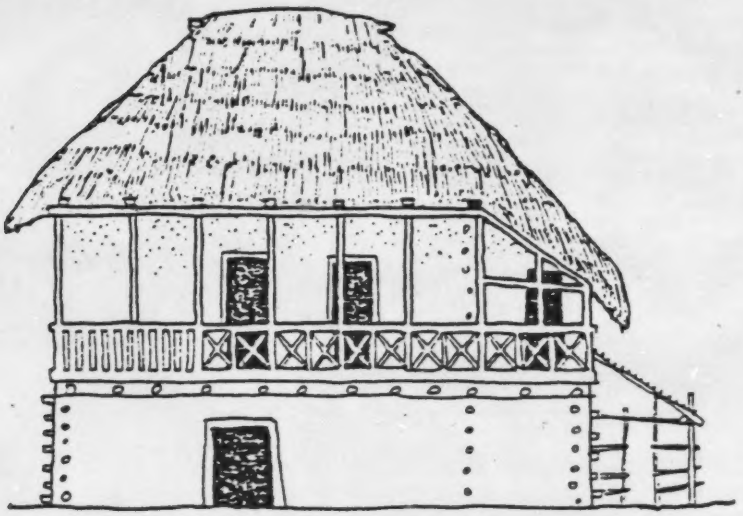
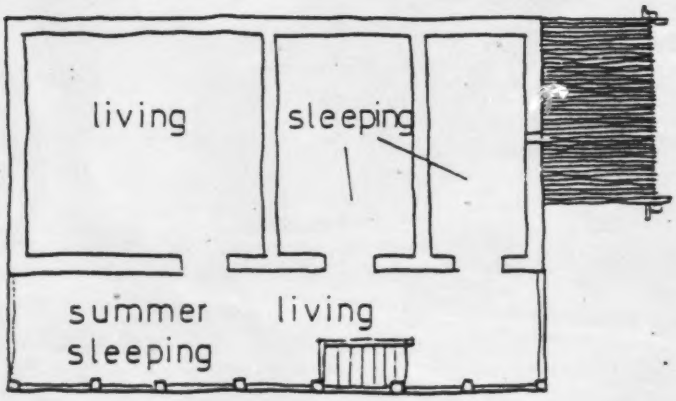


Fig C 16 MEZZININE HOUSE

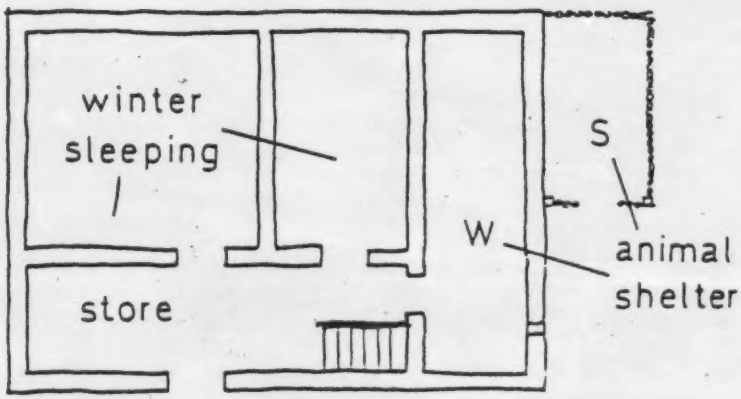
House Maklavan



Elevation



Upper Floor Plan



Ground Floor Plan

Scale

was not considered time wasted. A noticeable change occurs when, through alteration to the life style and economy of the family, time is valued in terms of money. People are less prepared to spend time on the upkeep of their buildings, but prefer to pay someone to do it for them, or use materials which will hopefully remove the need for maintenance. Hence, there has been a growing shift to the use of cement blocks, which are believed to be long lasting and maintenance free. Unfortunately the quality of the blocks produced is usually poor and deterioration is noticable. Roofing materials have shifted from those locally available to a widespread use of galvanised metal sheeting, which also performs less well than is commonly believed. The overall quality of building is deteriorating. The locally available materials are ideally suited to the local conditions, but they do frequently have problems. Thatch roofing, whilst being cheap and thermally excellent, deteriorates and requires replacement. This can be largely overcome by using simple preservatives. Various methods have been suggested. The tile industry, in the Astara and Behshahr areas, could be made more viable than it is already. Much of this can be achieved through improving the production and transportation systems.

The walling materials, especially the timber frame walls, are still popular because they are cheap, and last for many years. Given the high incidence of earthquakes, the use of timber should be encouraged. Overall, the use of timber has been restricted because of forestry control. Careful use of the forestry resources should be encouraged, but equally, selective use and replacement of trees will do more to ensure the continued existance of woodland in the area. Replanting is essential. The controls have not reduced the cutting of trees - it has continued

in a less noticeable form. Predominantly it is small timber that is taken whilst mature trees are left. This will only become noticeable in years to come when new growth is less.

Especially in the coastal areas, materials and design of houses which do not allow for air movement to combat the heat and humidity of the summer will provide inferior housing which will then need the additional expense of mechanical cooling.

A Careful use of the resources of the Caspian Region would enable the majority of the building needs to be met with local materials and skills, providing income and employment to a region, that, as with much of Iran, is becoming increasingly dependant upon the urban centres.

The trend has been towards increasing migration from the rural areas to the towns and from the Caspian to the larger industrial centres south of the Alborz mountains. In consequence, less money circulates within the local economy; skills are forgotten and the level of regional self sufficiency drops.

The condition and changes in the built environment are a reflection on the changing pattern in agriculture and production. It is in the advantage of the area to stimulate the use of its potential.

TRAINING WORKSHOP FOR BUILDERS

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TRAINING WORKSHOP FOR LOCAL BUILDERS AND ARTISANS.

BUILDERS WORKSHOP IN YAZD, CENTRAL IRAN

1 Introduction

The main basis of the approach taken by the Selseleh Integrated Development Project was aimed towards improving the living conditions within the region through active participation of the community and by the use of local resources.*

The four major activities of the S.I.D.P. lay in the fields of education, health, agriculture and physical services. These four activities were introduced through education, so that, while the immediate needs of the four aspects were being met, the local population were at the same time being trained to provide these things for themselves, and to eventually cease relying so heavily upon others to help them.

At the start of the S.I.D.P. work, 90 volunteers from the region were chosen and given a broad training in agriculture, health and education (initially primary and literacy education). After the basic training period these people were sent back to their villages where they could work with the local people to improve conditions in the area.

Because of the pressing needs for new facilities in the area, even though there was an extreme shortage of even relatively skilled builders, it was not possible to begin with a comprehensive builders training programme before starting on practical building work. Training had to take place whilst building was going on. Because of the impossibility of supervising every building site constantly, a number of bad building practices were incorporated into the earlier buildings. This was understandable given

* The Development Workshop were the architects and planners for the SIDP from 1975 to 1978.

the largely nomadic background of the people, who, unlike much of the rest of Iran, did not have a long and rich tradition of building to develop from.

In general, the 'builders' suffered from a combination of difficulties; lack of experience, skill and pride in their work.

At the time that the Builders training workshop was organised, some participants had been working in agriculture less than a year before. One had been and periodically continued as, the assistant cook in the S.I.D.P. canteen.

All the participants had one thing in common; the desire to learn and improve their buildings skills. Lack of pride in their work was primarily an expression of the low standard that had been accepted in the past. There had been very little exposure to work of good quality.

The building season in the Selseleh Region is between April and November. Buildings must be weatherproof by the time that the main rainy season begins. Interior work can carry on for a while, but by the end of December the weather becomes so cold that materials freeze and much of the work is slow and unproductive. Any training programme that was not to interrupt the scheduled building programme had to take place between December and April, when the participants could be involved entirely in training.

The first obstacle to be overcome was the location for the training workshop. The training required outdoor space that could be used for practical work and experimentation. Selseleh was unsuitable because of the winter climate.

Fig 1 LOCATION OF YAZD & SELSELEH

Yazd, in the centre of Iran was chosen becuase of

a) the climate was drier and milder.

b) the two master masons who had been primarily involved in the vault and dome programme came from Yazd and could provide the temporary accomodation and land needed, as well as knowing where to get materials and supplies from.

c) Yazd itself lies at the heart of an area with an extremely rich and well developed building tradition, and it was hoped that the exposure to a high quality workmanship would have a beneficial effect upon the participants of the training workshop. They would also be able to see, albeit in a different context, to what extent local resources can be used to meet all the building needs of an area. (Fig. 1)

A further incentive in moving the builders out of their own region was to bring them together as a more cohesive group, who would in future be able to undertake building projects as a co-operative of builders.

The workshop programme was paid for by the S.I.D.P., who also contributed a basic maintenance wage for the builders taking part.

In all, 14 trainee builders from Selseleh, two master masons from Yazd, and the four members of the Architectural and Planning group of the S.I.D.P. (Development Workshop) took part in the programme. The duration of the workshop was from January through to March 1977.

Accomodation and discussion space was provided in a house in Yazd, with a large courtyard where practical work, experiments and outdoor discussion took place. (Fig. 2)

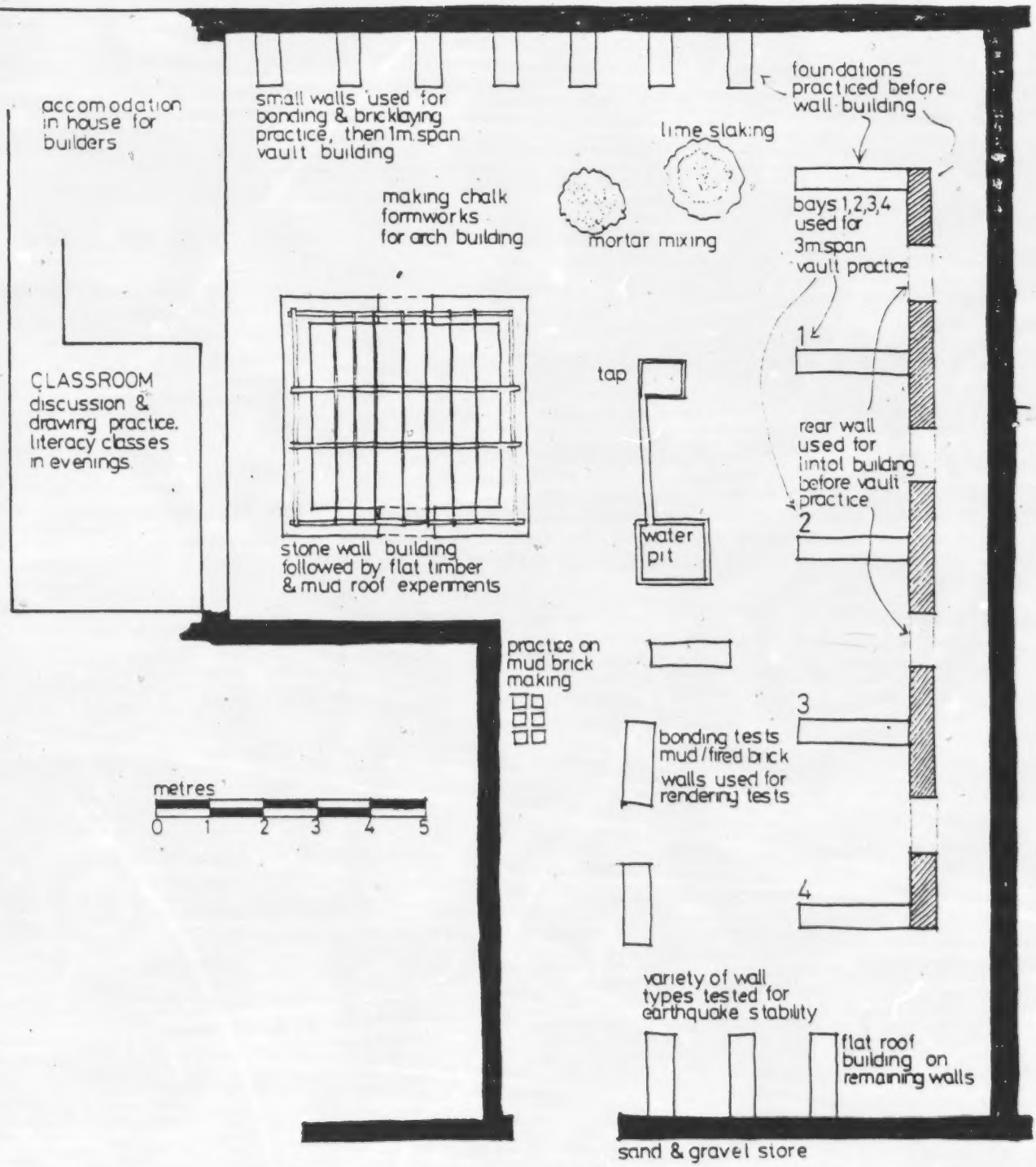

accomodation in house for builders
small walls used for bonding & bricklaying practice, then 1m span vault building
foundations practiced before wall building
lime slaking
mortar mixing
making chalk formworks for arch building
bays 1,2,3,4 used for 3m span vault practice
1
2
3
4
rear wall used for lintol building before vault practice
tap
water pit
CLASSROOM discussion & drawing practice. literacy classes in evenings
stone wall building followed by flat timber & mud roof experiments
practice on mud brick making
bonding tests mud / fired brick
walls used for rendering tests
metres
0 1 2 3 4 5
variety of wall types tested for earthquake stability
flat roof building on remaining walls
sand & gravel store

Fig 2 LAYOUT OF BUILDERS' WORKSHOP

There were two closely inter-related aims in the workshop; firstly to develop indigenous building methods through the pooled knowledge of the participants; and secondly to train the village builders in practical and organisational skills so that they were equipped to meet most rural shelter needs without dependance on city based contractors, engineers and building materials.

The workshop was not, however, a conventional teaching process. Each aspect of the programme was based upon the sharing of experience amongst all the participants. This experience was discussed and the best solutions to meet the needs and potentials of the Selseleh area were collectively dicided upon. Each solution was tested and developed through practical work in the courtyard. It was stressed from the beginning that, whilst some of the participants had greater knowledge than others, each person had something valuable to contribute. In practice, as many valuable suggestions came from people who had no specialised background in building as came from those who had been trained, i.e. the master masons and the members of the Development Workshop.

The builders from Selseleh had an invaluable understanding of what could or could not be done in their own region. Without this, some ideas could have been developed without being entirely suited to the local conditions.

2 Methodology

The methodology adopted for the workshop was: learning through discussion, through practice and through experimentation. As an additional part of the workshop, basic literacy classes were conducted in the evenings, since the majority of the builders were illiterate. These literacy classes were directly related to the subjects being

dealt with in the workshop, and consequently took on a greater degree of relevance to the day to day life than was normal. Certain aspects of the workshop programme clearly demonstrated the need to be literate, most particularly the ability to read architectural drawings and understand their basic requirements; and to be able to organise the building process - ordering of materials, accounting etc. These skills were important if the builders were to take on Government contracts in Selseleh.

3 The Workshop

Before any practical discussion was to begin dealing with building in particular, it was important to establish an understanding of what sort of approach should and could be taken in the development of the Selseleh Region.

The builders were asked to identify the negative and positive aspects of the Selseleh area. Having listed the resources/potentials and shortages/problems in the area, they were then asked to see to what extent the resources could be used to overcome the problems in the area. Because of their background, many of the ideas related to the agricultural and animal husbandry. Through the discussion a strategy for the practical development of the Selseleh Region was developed which included ways of increasing employment, through the establishment of workshops, for metal, handicrafts, woodworking etc., and kilns, for producing bricks, chalk and lime, all of which were locally available. They also identified certain essential facilities which could and should be provided - new roads, public buildings, work places etc., and the extent to which the people of the area could do this themselves and what role or assistance the Government needed to provide to supplement their own potential. One of the major difficulties was the shortage of capital required

in establishing many of the things required in the region, and this was seen as a major area of needed assistance. However they felt that by stimulating the local economy, they would be increasingly capable of improving conditions in the region without assistance. The builders suggested that the poor quality of the built environment in the area was mainly a reflection of the economic poverty of the area, and illustrated this by saying that if there was more money in circulation, more people would be able to afford better materials, and to improve the use of existing materials.

More detailed discussion dealt with the provision of public facilities, looking particularly at the role of the Government and its relationship with the village community. The builders felt that the best results occurred when village financed and participated in the process, but that this was seldom possible because so little money was available. On the other hand, when the Government provided a building, its design and operation seldom met the specific requirements of the village and its environment, and the people tended to neglect the building after completion. The suggested solution was through participation of the people and the help of the Government, where the future users would be involved from the beginning, from decision making through to use and maintenance, and could harmonise the building to their needs.

For such a strategy to work, it was essential that the builders could read and interpret architectural drawings, so that they could take on Government work in the area and produce simple plans for the local buildings.

4 Drawing designs and building methods

The discussion on drawing, design and building methods was introduced by asking the builders to draw their own

homes. Whilst these initial drawings were in many cases not very clear, they provided the basis for discussion of buildings with which they were already familiar. With these buildings, basic principles of design and construction were illustrated; for example, the positioning of windows in relationship to the building's orientation. A stereotyped cardboard model was made, with which the different views of the standard house in Luristan could be seen in terms of plans, sections and elevations, by removing parts of the building. (Fig. 3)

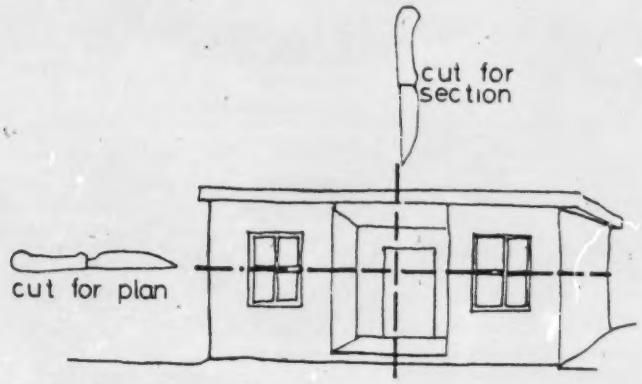


Fig 3 CUTS ON MODEL

Through this the builders quickly developed a basic ability to produce more accurate drawings. Methods of dimensioning their drawings and using scales, i.e. 1:100, 1:50 were introduced.

5 TECHNICAL AND PRACTICAL CONTENT OF THE 'WORKSHOP'

5.1 Overall approach

The various elements of the building were dealt with from the ground upwards. At each stage the basic requirement was discussed, including the principles involved, and from this analysis, a variety of solutions were investigated. Those that seemed suitable for the Selseleh Region were practiced on in the yard, with demonstrations of the correct or best method.

The detailed programme of the workshop was along the following lines: Each new subject was introduced and its function explained. The builders were asked to describe the methods that they were acquainted with. Members of D.W. or others with specialised knowledge, added information where necessary which was also analysed. The most suitable methods were selected and the group moved to the practice yard where the ideas could be demonstrated and experience gained in how each stage of the building should be done.

In addition to basic building techniques, certain specialised subjects were dealt with, In this case, because Luristan has a high incidence of earthquakes, special attention was paid to the introduction of earthquake resistant features in building and the principles explained.

5.2 Site evaluation

It was explained that before positioning the building, one should find out whether there were any features in the site which might affect the type of structure or the future performance of the building. These could be simply investigated by observation, to note evidence of flooding, marshy ground, rubbish tips, the proximity of trees etc.; and by physical investigations, which basically meant

digging trial holes to find out what the ground was like, the height the water table, etc.

All of these could influence the location of the building and the type of foundation used.

Later on in the programme simple methods were demonstrated for analysing soil types. At this stage the behaviour of different soil types was explained.

5.3 Foundations

The Function of foundations was discussed, and the builders described the method they knew. It was pointed out that many buildings in the area did not have proper foundations, and that where used, the method of building the foundations was often poor. The discussion stressed the importance of having properly built foundations since the whole weight of the building rested on them.

Practical demonstration focussed upon two foundation types suitable for small buildings of less than 2 storeys, one for firm and stable ground and the other for unstable ground.

In Selseleh, the accepted materials for foundations were lime and earth for the mortar (Shefte), and stone. The lime used in the mortar was not always slaked before mixing, which resulted in cracking when the lime came in contact with humidity in the soil. It was stressed that lime should always be soaked in water before use.

Stones were usually thrown into the foundation, with no attention paid to laying them properly. This too resulted in weak foundations. The correct laying of stones was demonstrated and practiced.

5.4 Walls

The builders were asked to describe the various functions of walls in a building. Their answers were comprehensive and included the following requirements:

- to be able to support own weight, roof load and snow.
- to provide shelter from undesirable climatic effects i.e. rain, snow, sun in summer.
- to provide security
- to make a boundary for the family
- to keep moise out
- to have stability against earthquake, flooding and other accidents.
- to be fire resistant.

Ways of meeting these requirements were discussed and the various wall types used in Selseleh were considered, both in terms of how they performed and how they could be improved.

a) Packed Earth walls (Chineh). The simplest and cheapest of the walling types used mud and straw, placed in lumps on the wall so that the wall is built up in 50 cm layers. The strength of these walls was low and two suggestions were made 1) that a ram and formwork could be used so that the mud would be compacted and have a greater load bearing capacity. 2) That improved water resistant renders should be used to stop surface deterioration.
Both these suggestions were developed upon through practical test walls.

There was a general concensus of opinion that these walls were not very strong and that where possible alternative wall building systems should be used. They were regarded as being satisfactory for building perimeter walls to courtyards. (This was probably the

most widely used method of wall construction in the Selseleh plain.)

The builders remarked that in building these walls it was essential to remove all rubbish, plastic, cloth and organic material which, if left in would weaken the wall. This applied equally to other walling systems using earth.

b) Mud brick walls. It was agreed that these were better than the packed earth walls. They have greater compressive strength, but, the bricks used in Selseleh were not well made and were easily damaged by rain, snow and impact. The mud bricks made in Yazd were of greatly superior quality, at times achieving strengths which nearly equalled that of fired brick. By comparing the process in Selseleh with that of Yazd, a set of basic guidlines were established.

1) Ground soil, particularly that which has been used for agriculture, has organic matter in it, and should not be used.
2) The earth must contain no rubbish.
3) Earth must be soaked so that all lumps are dissolved.
4) Clay will crack during and after drying. There must be at least 30% sand in the mix. *
5) Straw can be added to reduce cracking if there is a shortage of sand.
6) The mud for brick making must be thoroughly mixed before use.
7) Mud brick should not be used before it has dried properly. Where the clay content is high, the bricks must be dried in the shade gradually, and it will take longer.

* Different ratios of clay and sand will produce bricks with different properties which can be used advantageously i.e. More sand gives greater resistance to water damage, whilst more clay produces a stronger brick in compression.

These guidelines suggested that there was a great deal more skill involved in making the bricks than had normally been applied in Selseleh.

The way that bricks were laid in the wall could also be improved. There was very little bonding between the front and the back of the wall, and between each layer of bricks. In the event of movement, i.e. during an earthquake, the wall could easily crack. Exercises were conducted to ensure that everyone knew how to lay bricks properly.

A common habit in Selseleh was to build a wall which was part mud brick, on the inside, but faced on the outside, with fired brick, to provide protection against rain and to improve the appearance of the building. This method was extremely popular since the finished effect of fired bricks was achieved at a fraction of the cost. It highlighted a major problem which had to be explained and demonstrated. Mud bricks can only be laid with mud mortar: conversly, fired bricks cannot be laid with mud mortar as there is no adhesion. It is extremely difficult to tie these two materials together, and the likelihood is that the fired brick facing will peel off and collapse.

A variety of experimental walls were built, using different ways of bonding the fired brick into the mud brick. For each wall, the footings were dug out and flooded so that the wall collapsed to one side, in the process accentuation the behaviour of the two incompatible materials.

c) Fired brick walls. Whilst fired bricks have greater strenth than mud brick, it was pointed out that the mortar that is used to lay the bricks, and the way in which each brick is laid can make a great difference in the quality of the finished product.

Common faults in bricklaying were identified and, after discussing the reasons why, the correct method was demonstrated and practiced upon.
These faults included: 1) Using incorrect mortars. Various mortars were experimented with. To achieve a balance between cost and efficiency, a lime/Sand mortar was agreed upon as being satisfactory for most situations in Selseleh.
2) Bricks should be dipped in water before laying to improve adhesion.
3) Bricks were usually laid with no mortar between vertical joints. This practice lead to weak walls and was to be avoided.
4) The pattern that bricks were laid in seldom incorporated any proper bonding, either through the brick from one face to the other, or between one horizontal course and the one below it. The practice of filling in the middle of walls with broken bricks in order to save money was discouraged. The participants of the workshop practiced on various types of bonding patterns.
5) Because it was easier, a common practice was to build up walls at either end, and then fill in the wall between afterwards. This produced weak corners which fail in earthquakes, and the builders were encouraged to complete one course at a time.

Some of the builders knew how bricks should be laid, but had seldom bothered. It was stressed that, by taking care and attention at each stage of the building, the finished product would be of better and stronger quality.

d) Stone walls. Many houses in Selseleh had stone walls but these were usually of the 'rubble stone' type,

held together with mud mortar. Where cement or lime based mortars were used, the quantity of martar was often greater than stone, producing extremely expensive walls. A skilled stone mason from the mountains south of Yazd was invited to come and talk about and demonstrate how stones should be used in wall building.

By first observing then participating, the builders could compare how they had been using stone with the way that was being demonstrated.

As in fired brick walls it was important with stone that the individual units should be laid so that there was proper bonding in the wall. There should be a stone laid through the wall to at least ⅔ of its width every 1.5 metres. Larger stones should also be used round doors and windows and at all corners. Most of the builders had been accustomed to using stones unselectively. The stone mason showed them how to select a stone and position it so that it fitted as closely as possible into its position. In this way much less mortar was required and money would be saved.

In the period that followed the training workshop, one of the most noticeable improvements was in the quality of the stone wall building.

5.5 Renders

Because many of the walls used in Selseleh had poor resistance to rain, a number of experiments were carried out on different and improved types of rendering mixtures. By comparing these with the mixtures normally used, the builders selected several that they felt were applicable and could be easily used.

Renders using bitumen and emulsifiers were the most acceptable, since the raw materials were readily available and both easy to mix and apply.

As an essential part of these experiments and the selection of the right materials for mud brick amking, simple methods of soil testing were introduced. By placing a sample of the soil in a bottle or jar, adding water and then allowing the contents to settle, one could get a good indication of the type of soil, how much sand and how much fine silt or clay it contained. Having explained the proportions of sand to clay that were desirable for brick making, from this test the builders could decide whether the proportions needed to be altered.

5.6 Openings.

Discussion first of all dealt with the position of openings in a building, in relation to climate and earthquakes, and their function and then the methods for making lintels. These included timber and steel lintels; it was stressed that the material spanning an opening should extend well into the walls on either side. Various types of arched lintels were investigated, ranging from almost flat arches to semicircular, and different types of arch were built. One of the builders suggested a combination of wood and bricks which was also built producing an almost flat lintel. Practice also included making formwork with chalk for use in arch construction.

5.7 Roofs

Because the programme was geared towards the needs of the Selseleh Region, two types of roofing were discussed and developed upon.

a) Flat timber roofs. This was the standard roof of the region, used in nearly all building. The builders

described the local method: placing poplar tree (Tabrizi) beams, usually three per metre, over which boards were laid. On top of the boards, cardboard was used to seal any gaps in the boards. This was covered by 15 cms of compacted earth. Where money permitted, covering layers of cement, hessian and bitumen were used to provide a proper waterproof finish. The depth of compacted earth, which in the villages provided the waterproof layer, was not reduced when cement and bitumen were added on top.

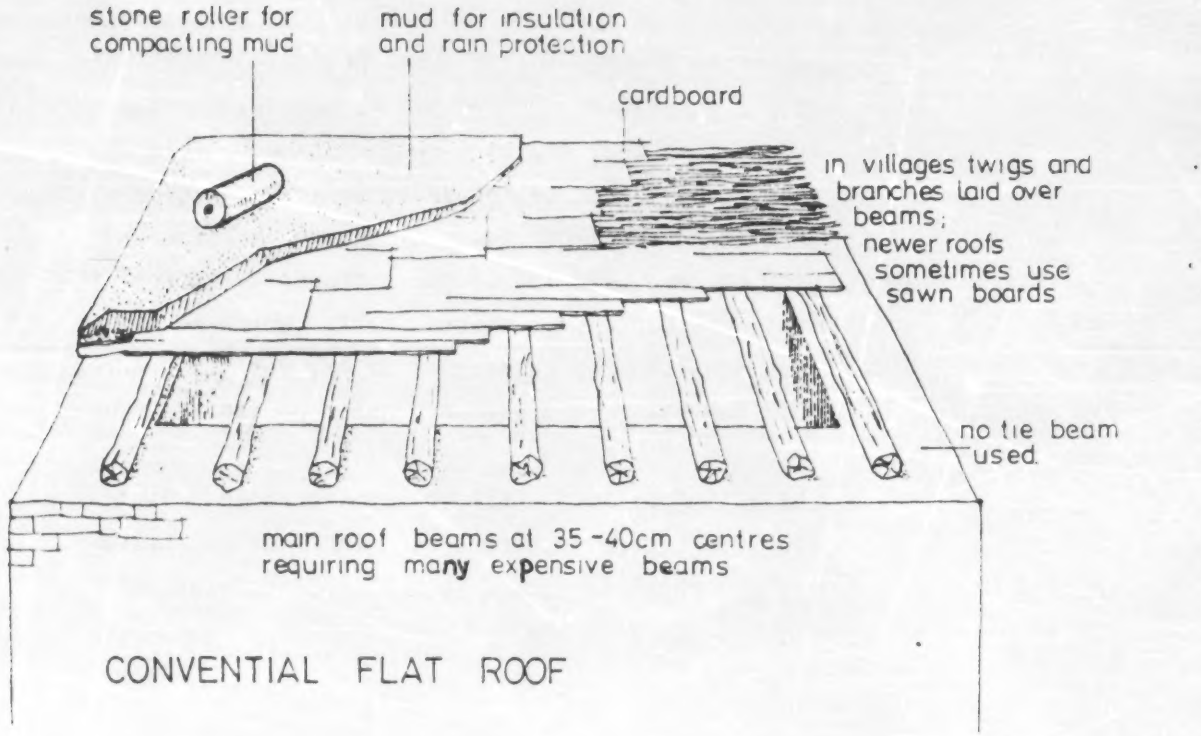
The weight of such roofs was considerable. Suggestions were made to reduce the number of expensive large timber beams, and to use instead fewer main beams supporting smaller, and considerably cheaper, subsidiary beams. (Fig.4)

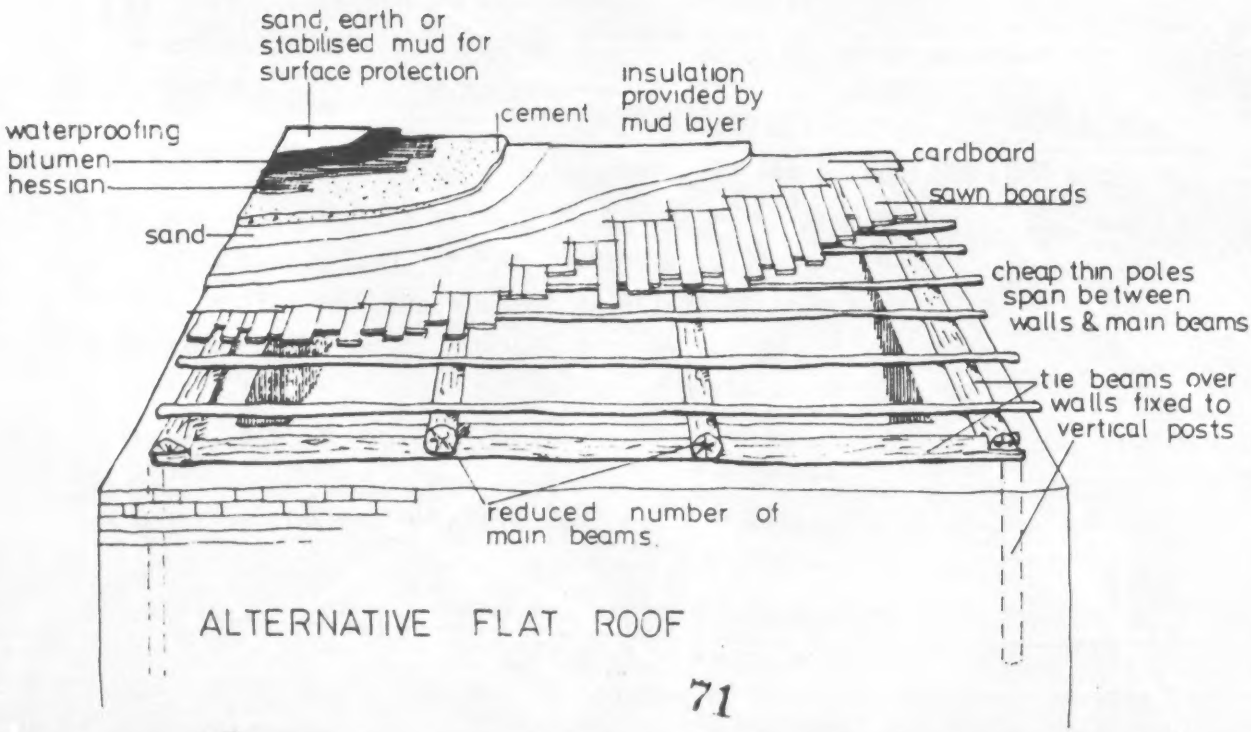
Two experimental roofs were built to develop and show this idea in practice. Wall plates were also used to tie the beams together and fix them to the walls. This was important in an area subject to earthquakes, since failure of buildings often occurred when the roof fell off the walls. (Fig.4)

Whilst the Selseleh region received considerable rain and snow fall during the winter, roofs were seldom laid with any slope. Drainage off the roof relied on piling up the earth on the roof at one end, which increased the weight and was not very effective. This could be simply resolved by laying the beams at a gentle slope, hence reducing the amount of earth needed and the consequent weight.

b) Vaulted Roofs. The Iranian system of vault building with fired brick, mud brick or stone needs to use no shuttering during the construction process, avoiding a wasteful use of material.

Fig 4 FLAT ROOF EXPERIMENTS


stone roller for compacting mud
mud for insulation and rain protection
cardboard
in villages twigs and branches laid over beams; newer roofs sometimes use sawn boards
no tie beam used
main roof beams at 35-40cm centres requiring many expensive beams
CONVENTIAL FLAT ROOF



Because this type of roofing was particularly applicable to public bath and high fire risk building in Selseleh, but was no longer a local skill, the Yazd master masons, who were skilled in this technology, were asked to explain and teach the method of vault building. In discussion, the various spans and relevant wall thicknesses required to support vaults were explained, as well as the basic principles. Practice (Fig 5) was initially on small 1 metre vaults, from which the builders progressed to 3 metre spans. Visits were also made to various domestic and public buildings in Yazd, where vaults and domes are the most common roofing method. The builders could see a wide variety of spaces covered simply and efficiently. They requested that some of the more complicated vault systems should also be demonstrated, to allow them to compare these with the method they had learnt.

5.8 Towards the end of the workshop programme a series of discussions were held on various subjects related to Selseleh and to the organisational skills that the builders would need when operating independantly in the future. The effects of earthquakes on building were outlined, and followed by ways in which the building could be made to withstand them. Many of the principles outlined during the workshop were involved in this: bonding in walls, positioning of openings, roof construction, but overall emphasis was put on always building with care and precision.

Discussion also covered the organisation of the workforce on the building site, ordering and estimating for materials and equipment, and costing and keeping records. These were all skills which would be developed further after returning to Selseleh to build.

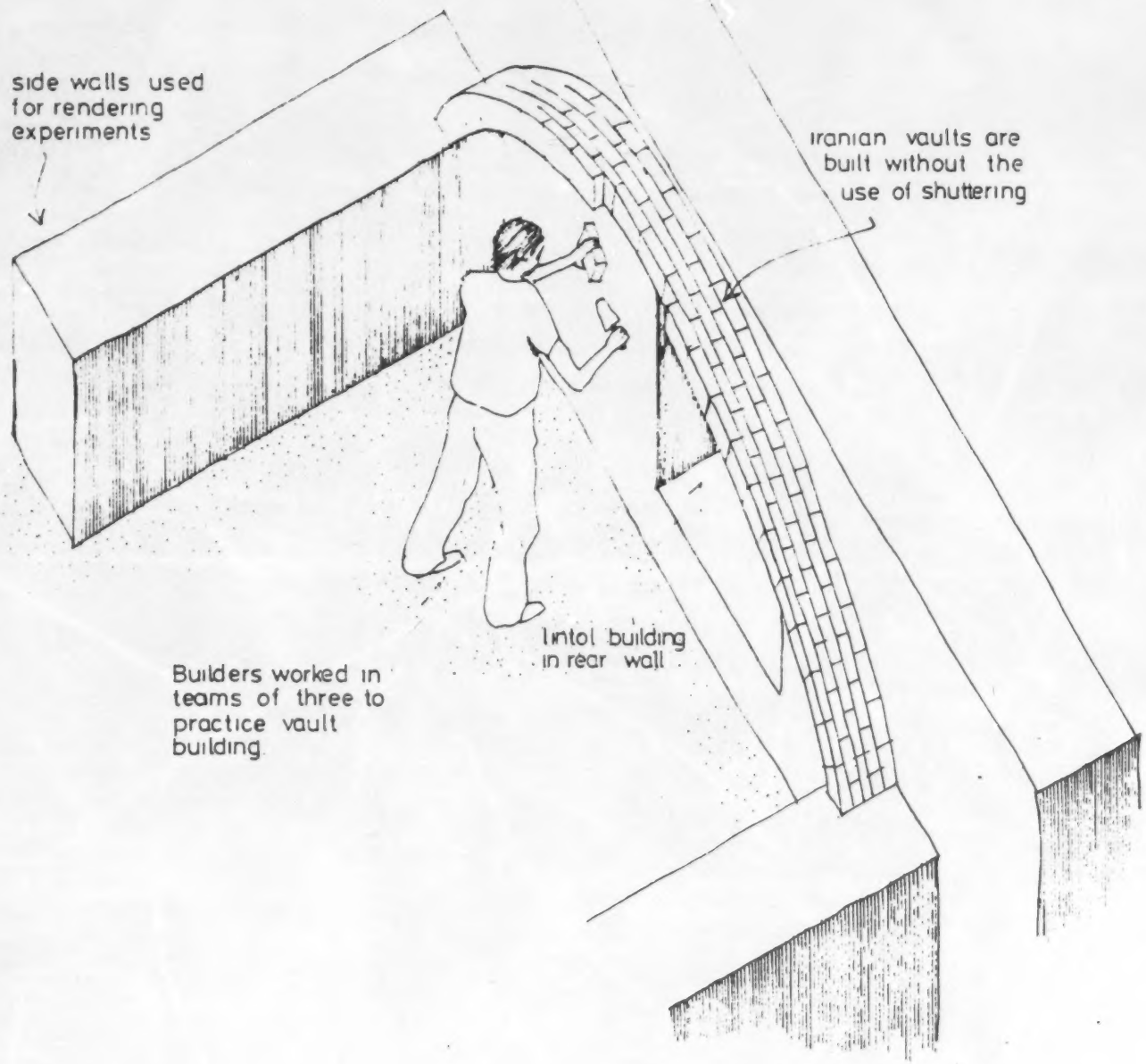

side walls used for rendering experiments
Iranian vaults are built without the use of shuttering
Lintol building in rear wall
Builders worked in teams of three to practice vault building

Fig 5 THREE METRE SPAN VAULT BUILDING
Each area was used for other practice exercises as well.

5.9 Conclusion and Continuation

The workshop was not seen as a finite process, but instead the beginning and establishment of an educational methodology which the builders could use to further develop themselves and their indigenous methods. This was based upon identification and problem solving, and by sharing each others knowledge. The process of discussion, practice and experimentation was carried over into the ordinary building work in the Selseleh Region.

The range of subjects and skills introduced in the workshop was broadened in the practical work that followed.

Because of the builders' improved capability, it was possible to devolve to them a large amount of the responsibility for the building requirements in the Selseleh Region. With this responsibility came the need to find more people to assist them in meeting the building needs of the area. Just over a year after the initial Builders Workshop programme, the original builders organised a second workshop to go over what they had learnt and to pass on the knowledge to a new group of trainee builders.